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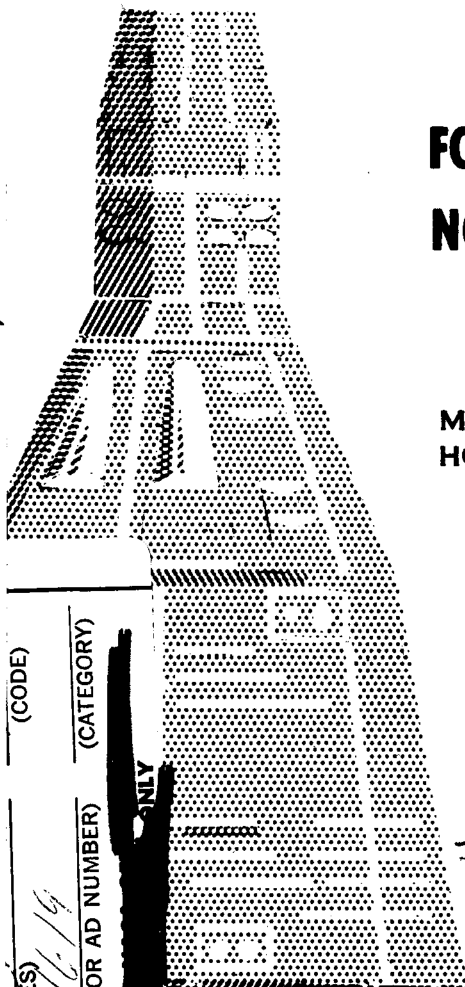
PROJECT GEMINI (U)

QUARTERLY STATUS REPORT

NO. 7

FOR PERIOD ENDING NOVEMBER 31, 1963

FOR NASA PERSONNEL ONLY



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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

PROGRAM GEMINI

STATUS REPORT NO. 7

for

PERIOD ENDING NOVEMBER 30,1963

By Manned Spacecraft Center

INTRODUCTION

This status report is the seventh in a series of reports on the second NASA manned spacecraft project, Program GEMINI, and covers progress through November 30, 1963. The sixth status report covered the progress through August 31, 1963.

Spacecraft 1 testing has been completed and the spacecraft and the first launch vehicle was delivered to Cape Kennedy in October 1963.

A major configuration change to the Gemini spacecraft was the addition of an 8.3-foot drogue parachute system. This system will provide aerodynamic stabilization to the spacecraft during the last portion of reentry.

A considerable amount of testing was conducted in the TE-385 Retrorocket Program which included development test firings, full-scale test of the Mode II abort system, and sea-level static tests.

MANUFACTURING

Major modules were mated August 25, 1963, and the final phases of spacecraft 1 testing were started. Test were completed and a rollout inspection was held on October 1, 1963. The spacecraft was delivered to Cape Kennedy on October 4, 1963.

Spacecraft 2 is in the final stages of wire bundle and equipment installations. Delays encountered because of engineering changes, late equipment deliveries, and equipment failures are still in evidence, but have been overcome to the extent that the major modular systems tests are scheduled to begin in January 1964. Upon review of discrepancies, the adapter was judged unsuitable for GT-2 and a reallocation of adapters was deemed necessary. The next adapter in the production line was selected. This adapter will be in the white room by early December 1963.

Spacecraft 3 was ready to enter the white room on November 30, 1963. Final stages of work included incorporation of engineering changes, shimming for cold plate installations, shingles fitting, and hatch rigging. Fabrication of wire bundles has started. Two major pieces of hardware previously in manufacturing for spacecraft 3 were reallocated and the next article on the production line was selected with no effect on schedule. These were: the adapter, assigned to spacecraft 2, and the reentry control system (RCS) structure, sent to Rocketdyne for use in research and development testing.

Spacecraft 3A is in the white room. Incorporation of engineering changes, installation of shingles, and rigging of hatches continues. Work on wire bundles was started. Incorporation of engineering changes and installation of fairings on the adapter continues. Installation of coolant lines and brazing of the Orbital Attitude Maneuvering System (OAMS) lines are complete. Reflective tape installation is complete. Plans are to ship the adapter to the test site by December 8, 1963. Subsequent activities will be test equipment installation and checkout and adapter modules installation and checkout. These activities must be complete prior to the start of radiator tests scheduled to begin late January 1964.

Early stages of manufacturing of spacecraft 4 include the installation of battery, enviromental control system (ECS) module, and cold plate support structures, ECS flange structure, and structure forward of the small pressure bulkhead. The lower floor structure is complete. Installation of the pedestal support, parachute, and umbilical fittings is in process. The horizon scanner fitting has been installed. The structure is approximately 74 percent complete. The RCS module structure is in final clean-up. The rendezvous and recovery structure is undergoing a configuration change for the two-drogue system. The upper engine mounts are in work on the adapter. The lower quarter panels are in fabrication.

Manufacturing of spacecraft 5 includes the installation of landing gear fittings, equipment support structure, equipment door sills, and structure forward of the small pressure bulkhead. Installation of shear webs and battery support structure, and trial fit of hatch hinges has started. The structure is approximately 52 percent complete.

Fabrication of the small pressure bulkhead for spacecraft 6 is in process. Some final spot welding must be completed before the bulkhead can be installed in the spacecraft structure. The structure is approximately 37 percent complete.

Boilerplate flight article 1A is now scheduled as a backup to GT-1 and will be flown only in the event that GT-1 does not meet the mission objectives. The spacecraft is scheduled for delivery to Cape Kennedy prior to December 15, 1963. Time estimated for spacecraft flight preparations in the industrial area indicates that the spacecraft could be ready to go to the pad within a month after the flight of GT-1 (as currently proposed).

GEMINI GROUND TEST - CURRENT SPECIMEN STATUS

Static Article 5.- McDonnell Aircraft Corporation's calm-water flotation tests have been completed, and the static article is now in the manufacturing area and in the final stages of modification to the -301 configuration. Spacecraft systems test power checks are scheduled to start December 2, 1963. The static article is currently scheduled for completion in early December 1963, and will then be shipped to NASA for flotation, training, and egress tests. It is expected that the flight article will be shipped in mid-December 1963.

Static Article 7.- This unit is in manufacturing, and is currently scheduled for completion on December 10, 1963. Current estimates indicate the structure is approximately 50 percent complete. The static article will then be shipped to Northrop-Ventura for complete parachute-system test drops. Parts problems for this article are being investigated; however, delivery by mid-December 1963 looks highly probable. The master schedule shows that two rendezvous and recovery sections will be furnished to Northrop-Ventura for use in conducting three test runs. Upon completion of the first run, the rendezvous and recovery section will be returned to McDonnell Aircraft Corporation to be rebuilt, and returned to Northrop-Ventura causing some delay in the third run. The cost of manufacturing a third rendezvous and recovery section, compared to the cost of shipping and repairing one of these sections is under investigation.

Static Article 3.- This unit is now located in the test lab area where it is being prepared for heat shield backup support structure tests. Testing has been delayed because of the late delivery of heat shield 2. The test completion date on this unit is pending the release of the -17 configuration drawings by engineering and subsequent scheduling of modification and pyro demonstration tests.

The heat shield is currently on material review request (MRR) for voids in the ablative core filler. It is anticipated that disposition will be completed in time for shield delivery to the test lab in mid-December 1963.

Static Article 4.- This unit is now located in the test lab where cycling and ultimate pressure tests are now in progress. During the cycling phase of this test run, the left-hand hatch blew open. Investigation revealed that interference between a torque-box cover attach-bolt and the crank assembly restricted the over-center travel of the latch mechanism. The test was re-run under various test setups in an effort to repeat this condition. As a result, it was proven that the blown hatch resulted from the interference condition. It was also found that the degree of latch engagement varied with the speed at which the latching handle was closed. Engineering will add a pointer to the latching mechanism to indicate when it is fully engaged.

Rework is now in process to remove interference and re-rig the left-hand hatch. It is anticipated that the rework will be completed by December 7, 1963.

The Northrop-Ventura parachute qualification tests on static article 4 will be cancelled. Static article 4 will be modified to the -3 configuration and used for the final qualification tests of the high-altitude drogue parachute configuration.

Static Article 2.- This unit is in the early stages of manufacturing. The ECS frame and lower floor portion are complete. Positioning of the torque box on the sill structure prior to welding is in process.

Boilerplate 3A.- Boilerplate 3A is currently scheduled for delivery to the test lab from manufacturing on December 10, 1963.

Delivery and Launch Schedule

A proposed delivery schedule for the spacecraft and launch vehicle, and the Agena target launch schedule are presented in figure 1.

SPACECRAFT

The following section contains information which delineates the status of the spacecraft and its systems.

CONFIGURATION AND WEIGHT

Configuration

A major configuration change to the Gemini spacecraft has been made during this reporting period which consisted of the addition of an 8.3-foot drogue parachute system. Its purpose will be to provide aerodynamic stabilization of the spacecraft during the last portion of reentry; namely from 50,000 feet to 10,000 feet, instead of depending upon the reentry control system as previously planned. This parachute system also provides the time to jettison the reentry control system fuel and oxidizer without damaging any equipment.

Several minor configuration changes were also made. One of these changes increased the cockpit area to accommodate a 90-percentile man on early spacecraft with the later spacecraft to accommodate a 95-percentile man in lieu of the original requirement for a 75-percentile man. Another change incorporates a sealed adapter compartment with controlled venting during launch to provide the desired pressure differential.

Weight

During this reporting period, the following launch weight changes have been recorded. The 2-day rendezvous mission configuration spacecraft weight, with parachute landing system, increased from 6,973 pounds to 7,066 pounds, and the 14-day mission configuration spacecraft increased from 6,786 to 6,867 pounds. These increases confirm that the weight trend of 30 to 35 pounds per month increase noted in the last report is still valid. This trend has now existed for over nine months. As in the previous periods, most of the weight changes reported were very minor (plus or minus 1 to 3 pounds) and tended to cancel each other. The only major weight changes reported during this period were in the adapter. An increase of 60 pounds was made in the retrograde rocket system and it resulted from strengthening required as a result of the previously reported abort test failure. It is anticipated, however, that additional tests now scheduled may reduce this increase by as much as 50 pounds. An increase of 12 pounds resulted from replacing the internal gold plating on the equipment section of the adapter with aluminum foil because of corrosion caused by the plating. The bright internal surface is required for thermal control. Additional work is being done to find a suitable plating technique. These efforts in both areas may succeed in reducing the weight increase for this period by at least one-half which will improve the current trend considerably.

STRUCTURE

During this quarter, launch loads were applied to test articles at both Martin Company and McDonnell Aircraft Corporation. Also, the spacecraft vibration survey was completed; and design improvements were initiated on the hatch mechanism and drogue parachute incorporation. Problems have arisen and the resolving action has been initiated about retrobeam over-heating at high-altitude abort, propellant booster dome rupture at high-altitude abort, the static test-to-failure at Martin Company, Martin Company's buffet test results, and beryllium shingle manufacture.

Interface tests.- Martin Company applied the ultimate tensile and ultimate compressive launch loadings to their test specimen in the latter part of July 1963. These two critical loadings are: (1) their transonic buffet with internal compartment pressure, which gives an equivalent load at the "spacecraft-launch vehicle" interface of 110,000-pound tension and 77,600-pound compression; and (2) transonic buffet without pressure, which gives an equivalent load of 67,500-pound tension and 120,500-pound compression. The ultimate conditions at second stage burnout were applied, maintained, and then a simulated aerodynamic heat pulse applied. Both the Martin Company's forward skirt and upper oxidizer tank structure and the McDonnell Aircraft Corporation spacecraft-adapter structure withstood the loads satisfactorily.

The test specimen at Martin Company had a forward booster skirt that did not meet production standards, and,therefore, it was instrumented with only enough strain gages (about twenty) to monitor the test. A great deal of concern has been expressed about the interface stress distribution between the skin-stringer adapter and the Gemini Launch Vehicle semi-monocoque forward skirt. This concern, about the effects of possible future design changes subsequent to the static tests, motivated Martin Company to initiate a follow-on test. The forward skirt was replaced with one that met booster production standards and the interface area was instrumented with some 400 strain gages, 90 percent of these on the compression side and the remainder on the tension side. The test was to proceed to failure. Prior to November 5, 1963, the date the test was to be conducted, it was discovered that the spacecraft-adapter lower-interface attachment ring contained excessive riveting, which made it nonrepresentative of production adapter structure. The test was not allowed to proceed and a meeting was held at Aerospace Corporation on November 13, 1963, between NASA, Air Force Space Systems Division, Aerospace Corporation, McDonnell Aircraft Corporation, and Martin Company to decide the course of action. It was decided to perform the transonic buffet ultimate compressive condition on the test specimen in the "as is" condition. Then the excess rivets will be removed and inspected by the spacecraft contractor. Following rivet removal, the ultimate compressive condition will be re-applied, then the ultimate tension condition applied. Finally, the ultimate compressive loading will be applied, then a pure bending moment applied until failure occurs.

Buffet tests.- During the first week of September 1963, the Martin Company conducted buffet model tests at Ames Research Center. They utilized an inertial compensated balance technique which is said to produce the moment due to buffet as a direct measurement. This is a new technique which did not meet with the approval of the Manned Spacecraft Center's Structures and Materials Branch of the Structures and Mechanics Division at the time of the test. The test was run between Mach 0.6 and Mach 1.14. The buffet loading was expected to peak and diminish in this region, but it was still increasing at a steady rate when the limiting Mach 1.14 flow was reached. Consequently, Martin Company recommended a follow-on buffet test in a higher Mach flow.

On November 22, 1963, Martin Company and Aerospace Corporation representatives briefed the MSC Structures personnel on their buffet measurement technique and the results of the first test. It is expected that by the first week of December 1963, the Structures and Material Branch of the Structures and Mechanics Division will recommend the follow-on buffet test to the Gemini Program Office (GPO), and Martin Company will submit the cost and schedule estimate of the test.

McDonnell Aircraft Corporation subjected static article 3 to limit-launch loads October 31, 1963, and ultimate launch loads the following day. The ultimate equivalent load was 138,500-pound compression and 49,700-pound tension. The structure withstood the load satisfactorily. The adapter skin on the compression side buckled locally, as expected, in sustaining the ultimate load; however, most of the buckle disappeared when the load was relieved.

On August 16, 1963, McDonnell Aircraft Corporation subjected the spacecraft nose fairing to 12.5 psi pressure over the surface of the fairing, which is 156 percent of design limit load. The fairing withstood the loading satisfactorily, deflecting only 0.058 inch maximum under the load.

The vibration survey on static article 4 was completed September 10, 1963. The static article was then sent to the Manufacturing Department where the heavy hatches were replaced with light hatches and other rework accomplished during the period of September 15 through November 2, 1963. The static article is now in the initial phases of its cabin-pressure cycling tests. The vibration survey uncovered some problem areas about the pulse code modulation programer, reentry control system valve package "B", tape recorder, and small pressure bulkhead. These areas are being investigated for improved mounting from a vibration standpoint. Relays mounted on the small pressure bulkhead are included in this investigation.

An improvement in the hatch mechanism to reduce opening and closing loads is in design. Segment and pinion gearing is being employed to reduce external opening and closing loads to 25 pounds and 30 pounds, respectively, at each end of a "T" handle with an effective 7-inch radius. The inside handle operating loads are the same, 25 pounds to open and 30 pounds to close, acting as a single load on an effective 11-inch radius.

Approval was given and design initiated to incorporate a drogue parachute in the recovery system. Structurally, this change will involve only the tip of the rendezvous and recovery section (approximately nine inches of structure below the radar ground plane). The design is conceived such that the loading on the reentry control system section adjacent to the rendezvous and recovery section does not exceed the present design load, even for a rotating spacecraft. A reoriented flight test program will be used to qualify this design. It is planned to proceed with a rendezvous and recovery section—reentry control system section static test, using the existing structures, and perform local tests on the redesigned rendezvous and recovery section later.

The second full-scale Arnold Engineering Development Center (AEDC) high-altitude abort test resulted in overheating the retrorocket support beams such that they failed immediately prior to the rockets ceasing firing. The over-heating was attributed to the close proximity of test chamber walls which were not representative of actual flight conditions at 70,000-foot altitude. However, the incident did point out a need for a heating investigation at higher altitudes, where the rocket plumes intersect to such an extent as to trap flow in the center and reverse it toward the beam structure. NASA, McDonnell Aircraft Corporation, and ARO met at the AEDC on November 7, 1963, to determine if a thrusting model test was technically feasible in any of AEDC's facilities. It was determined that the J-2A cell would permit a satisfactory test, but it is tied up with Titan III and Apollo projects until June 1965. The GPO is currently negotiating with the Air Force Space Systems Division for a few weeks of J-2A cell testing time during the month of February 1964. McDonnell Aircraft Corporation has been directed to proceed with model design and test definition.

Martin Company released a report, LV-211, during the previous reporting period indicating that if thrust is terminated between 40 and 105 seconds after launch, the booster's remaining propellants will rupture the upper tank domes due to drag deceleration of the vehicle. This, of course, implies we have a problem in the early Mode II abort region, (70,000-foot altitude occuring at about 93 seconds) where the normal procedure is to terminate thrust prior to retrorocket salvo. The analysis is admittedly overly conservative; however, very little is known regarding more refined analytical techniques for determining the loading. Therefore, at the last Abort Panel meeting on October 22, 1963, it was decided that Langley Research Center will perform model tests, producing fluid impact data from which a more realistic structural analysis can be made.

A review was held with McDonnell Aircraft Corporation on November 5, 1963, concerning the beryllium shingles for the reentry control system and rendezvous and recovery structures. Because of a strike early in the year as well as other manufacturing difficulties, shingle tests have been delayed. An important test, the docking impact load at -100° F, was rescheduled to be conducted two months earlier by integrating it with another test. The cross-rolled beryllium, used for Gemini, has presented a number of manufacturing problems in attempting to avoid crazing, flaking, porosity, lamination, and cracking flaws in the finished shingles. A meeting was held at Pioneer Astro Industries, Chicago, Illinois, on November 14, 1963, where it was decided that Batelle Memorial Institute would analyze these problems, and Pioneer Astro would use more chemical etching in the machining operation and lighter cuts where machine tools could not be avoided.

HEAT SHIELD

Materials and Testing

The questionable areas that appeared during the qualification testing of the prototype heat shield have been rescheduled to be performed on the static article 3 shield after completion of the other tests. These tests will be performed during the next reporting period.

The process standard that covers fabrication and quality acceptance testing for the heat shield has been rewritten during this period. The major change to the document was the addition of an acceptance testing procedure for the ablation material.

Manufacturing

The heat shield has been delivered and accepted for spacecraft 1. The heat shield is deficient since it contains some uncured ablation material; however, it is considered suitable for the mission of spacecraft 1. The heat shield has been fabricated for spacecraft 2 and was scrapped because of unacceptable strength of the backup structure. Corrective action has been taken which includes rework of the vacuum system and a revision to the process standard. The ablation material for the second static article 3 heat shield was not homogeneous and required excessive curing time. The investigation is continuing, but it appears that the catalyst is impure. This deficiency will not be limiting in the use of the second static article 3 heat shield, since the strength is not degraded.

SOLID PROPELLANT ROCKET SYSTEM

Summary

TE-385 Retrorocket Program.- Two development test firings were conducted during this reporting period. The primary effort on the retrorockets has been placed upon verification of the redesigned nozzle assembly. To this end, three static sea-level tests were successfully conducted.

Retrorocket Abort Test Program.- A second full-scale test of the Mode II Abort System was conducted ahead of schedule at AEDC on October 4, 1963. The purpose of the test was to verify the structural integrity of the redesigned retrorocket nozzle assembly in its operating environment. Since the motors performed without a malfunction under test conditions that were more severe than is anticipated in flight, the motor test was considered an unqualified success. However, as a result of considerable heating from the exhaust gases plus the rocket thrust on the beams, the structure failed after slightly more than 4 seconds of a 5.5-second burn time. Corrective measures to be taken as a result of the retrobeam failure will be reported in the structural section of this report.

TE-385 Retrograde Rocket

Schedule.- As a result of the successful abort test of the motors at AEDC, the schedule is now expected to be more accurate. Twelve research and development tests remain to be completed on the retrorockets. Motor development testing is now scheduled for completion by mid-January 1964. Motor qualification testing is scheduled to begin during mid-March 1964, and extend over a twelve-week period rather than four weeks as earlier reported. This additional time has been requested by Thiokol Chemical Corporation as a result of a change in temperature cycling requirements by McDonnell Aircraft Corporation, and a requirement for the use of spacecraft motor mounts during the static qualification test firings.

Initiator qualification has been successfully completed and pyrogen qualification initiated on schedule in mid-November 1963. Pyrogen qualification should be complete by mid-January 1964.

Retrorocket delivery for spacecraft 2 has been delayed until mid-March 1964, at which time the motors for spacecraft 3 will also be delivered. The March 1964 delivery is well in advance (about 7 weeks) of the required date for motor installation into spacecraft 2. A set of 4 motors with inert propellant has been delivered for spacecraft 3A.

Design.- The redesigned nozzle assembly has been shown to be structually sound in three successful sea-level static tests, one of which included a static side-load test of the nozzle as well as a full-scale altitude abort test at AEDC. No other design changes have been incorporated.

Tests.- A discussion of all testing on the retrorockets is contained in the following paragraphs:

a. Development tests. Seven developmental-test motor firings were conducted during this period. Of these seven test firings, only two firings were tests planned in the original development program. One motor was fired to provide a batch check on eleven motors cast for two abort tests at AEDC and the remaining four motors were fired in the second test.

In addition, seven other motors were cast for a third full-scale test at AEDC (retrograde test) which allowed 3 spares for the last two tests. Two of these motors will have grains exposed to 5×10^{-6} mm Hg vacuum for 14 days to determine the effects on ignition and burning of "space aging." Four other motors will be tested to the revised thermal cycle environmental tests which resulted from more recent thermal considerations by McDonnell Aircraft Corporation. Basically, the number of cycles has been increased and the temperature limits have been decreased. No test plans exist for the seventh motor.

Exclusive of the above testing, the remaining research and development tests to be conducted consist of three static tests in Group V and three in Group VI. Table I presents the sequence of environments. The motors fired in support of the nozzle redesign verification tests received the complete environment exposure required by Group V and were successfully tested. The batch check motor had static side loads of 2,400 pounds placed upon the exit cone after the motor had been fired. Failure occurred within the center of the plastic cone and not adjacent to the metal bulkhead. No cracks were observed in the nozzle metal/plastic interface after sectioning.

b. Qualification tests.

1. Pressure cartridge - Testing is complete with no failures reported. However, McDonnell Aircraft Corporation has not

TABLE I.- RETROROCKET DEVELOPMENT PROGRAM TO BE COMPLETED

Test Title	Test Group		
	III*	IV	VI
No. of motors/group	4	3	3
Temperature cycle	4		
Sequential vibration			
190° F		3	
60° F			
-30° F			3
Drop			
High temperature (190° F)			
Nozzle end		1	
Head end		1	
Side		1	
Ambient (+60° F)			
Nozzle end			
Head end			
Low (-30° F)			
Nozzle			1
Head			1
Side			1
Acceleration		1	1
Humidity		3	3
Temperature gradient		2	2

*Repeat to revised temperature cycle requirements.

reviewed the test report and thus does not consider the units qualified.

2. Pyrogen - Testing has commenced on the 50 units to be qualified and is on schedule with vibration testing already complete. Completion of this program should occur in mid-January 1964.

Retrorocket Abort Test Program

<u>Test Run No. 1</u>. The test discussed in the previous status report has been documented by AEDC in Reference A.

<u>Test Run No. 2</u>. The objective of this test was primarily to verify the redesigned nozzle assembly of the TE-385 retrorockets. To this end, full duration engines and lightweight I-beams were employed on a boilerplate adapter and test rig, thereby duplicating test no. 1. Test conditions of the first run were duplicated as closely as possible. Although all 4 motors performed properly with no evidence of cracking when sectioned into halves, the I-beam did fail because of temperatures higher than had been anticipated prior to the test. Corrective measures to be taken as a result will be reported in the structural section of this report.

Since the high temperatures encountered in this test are believed unrealistic compared to actual flight conditions and resulted from interference effects with the tunnel, the retrograde test has been cancelled. Heating during the retromode is to be obtained in scale model tests which will also be employed to determine heating effects during the Mode II abort.

LIQUID PROPELLANT ROCKET SYSTEMS

Schedules

The program milestone schedules are still being delayed as a result of hardware unavailability and thrust chamber assembly (TCA) development problems. The status of production hardware deliveries, the research and development program and the qualification program is discussed separately.

<u>Reentry Control System Production Hardware Deliveries</u>. - With the exception of the TCA's and explosive cartridges, all components for the RCS on spacecraft 2 have been delivered. Shipment of the remaining items should be complete by mid-January 1964. Approximately 15 percent

of the hardware for spacecraft 3 has been delivered; the remainder of which should be delivered by February 1964.

OAMS Production Hardware Delivery. - The compatibility test unit (CTU) is considered sufficiently complete to fulfill CTU test objectives, although a complement of TCA's was not delivered. The plan is to update the CTU with a complete set of production TCA's as they become available on a non-interference basis with qualification and flight hardware requirements. For spacecraft 2, all hardware has been delivered except TCA's and explosive cartridges which should be shipped by early February 1964. Spacecraft 3 hardware deliveries are about 10 percent complete. The remainder should be completed by March 1964.

Research and Development Components. - It is apparent from a recent investigation of tests conducted at Rocketdyne that the research and development phase will extend well into 1964. Rocketdyne specialists generally attributed most of their delays to a lack of test hardware, rather than development problems. One notable exception is the thrust chamber development effort which remains well behind other components due to technical problems as well as a lack of hardware. Prediction of a completion date is difficult because of the hardware availability uncertainties and because a definite method of resolving the orbit attitude maneuvering system (OAMS) TCA life problem has not been selected.

Systems Testing. - No system testing was conducted during this reporting period and only very minor testing has been conducted since early in 1963. Again, the reason is hardware unavailability. Completion of the research and development system test program is expected during the second quarter of 1964, unless hardware continues to remain unavailable, or other major development problems arise.

Qualification Testing. - As a consequence of the research and development programs' delays, the qualification program has experienced serious delays. In order to complete qualification testing in adequate time for support of a manned launch in 1964, it may be necessary to initiate qualification testing prior to completion of the development program. Because the program has been so adversely affected by a lack of hardware, manufacturing has been receiving major attention. According to the Rocketdyne program schedules, which in the past have been accurate in showing slippages, it now appears that the qualification program is firmer due to improved availability of the required hardware. Also, Rocketdyne has requested that McDonnell Aircraft Corporation supply a relative priority rating of components for the various spacecraft deliveries and for different types of tests.

[redacted]

TABLE II.- TOTAL TESTS CONDUCTED ON "PRESENT" DESIGN

25 Pound RCS

Specification Duty Cycle Time

Total with pulse mode: 136 sec
Total with continuous operation: 162 sec

Unit number	Test date	Actual burn time			NC*/Isp (percent)	Configuration (if different from production S/C 2)	Results
		Calibration	MDC	SS			
25 lb. FW RCS ZR 25.1	8-24-63	18	117		94	Low temperature glass wrap and non-explosion proof injector	Calibration, performance and 140.43 seconds to failure in RCS MDC
25 lb. FW RCS ZR 25.2	8-25-63	18	121*		90	Same as ZR 25.1	Calibration, performance and 145.9 seconds to failure in RCS MDC
25 lb. FW RCS ZR 25.3	8-25-63	18		162	92	Same as ZR 25.1	SS cut
25 lb. FW RCS ZR 25.4	9- 4-63	18			93	Same as ZR 25.1	Undergoing pulse performance
25 lb. FW RCS ZR 25.5	9-11-63	18	130.8		95.5	Chamber segment was HITCO material with a year storage	Calibration, performance, and MDC-TCA failed.
25 lb. FW RCS ZR 25.6	9-21-63	18	129		95.5	Had a non-explosion proof injector	Failed through can just up-stream of throat 90° 100 radial arc.
25 lb. FW RCS ZR 25.7	9-26-63	18	236		88	Conical injector and low temperature glass wrap	Failed - core assembly pulled out of can and injector *conical 8 tube injector
25 lb. FW RCS ZR 25.8	9-30-63	17	106		92	Same as ZR 25.6	Manual cut for temperature soak data
25 lb. FW RCS ZR 25.9	10-10-63	18	144		94	Same as ZR 25.6	Failed through can at nozzle entrance station.

FW denotes flightweight configuration.
ZR denotes engine test number.
* Apparent data discrepancy

MDC denotes Mission Duty Cycle operation.
SS denotes Steady State (continuous burning) operation.
NC denotes Nominal Condition.

[redacted]

[redacted]

TABLE II.- TOTAL TESTS CONDUCTED ON "PRESENT" DESIGN - Continued

25 Pound OAMS

Specification MDC

Calibration + Cape 16 sec
MDC 232 sec + 22 sec SS
Steady State 270 sec

Unit number	Test date	Actual burn time			NC*/Isp (percent)	Configuration (if different from production S/C 2)	Results
		Calibration	MDC	SS			
25 lb. FW ZO 25.1	8-20-63	18	232		90 calib	Low temperature glass and non-explosion proof injector	Mixture ratio shift 1.30 to .930 after 15 seconds of MDC. No failure.
25 lb. FW ZO 25.2	8-27-63	9			86	Same as ZO 25.1	Being vibrated. Not tested due to low performance.
25 lb. FW ZO 25.3	9- 3-63	21	117.1		90	Same as ZO 25.1	3 seconds verification and 2 day MDC
25 lb. FW ZO 25.4	9- 3-63	9		60	97	Same as ZO 25.1	Program cut. No failure
25 lb. FW ZO 25.5	9-16-63	18	202		95	Non-explosion proof injector	Failed - excessive char
25 lb. FW ZO 25.6	9-24-63	18	135-164		93	Same as ZO 25.5	Failed upstream of throat
25 lb. FW ZO 25.7	10- 9-63	20	165		94	Had a load carrying stainless ring welded to the can at the throat station and a non-explosive proof injector	Failed through side nozzle stayed in. Interrupted test.
25 lb. FW ZO 25.8	10-10-63	18	135		93	Had HITCO material in the chamber segment, and a non-explosion proof injector.	Failure mode-core assembly came out of shell and injector.
25 lb. FW ZO 25.9	10-10-63	12			93	Same as ZO 25.8	Scheduled for pulsing.
25 lb. FW ZO 25.11	10-63	18	171		94.5	Non-explosive proof injector and thick asbestos wrap.	Test cut because of loss of oxidizer flow.
25 lb. FW ZO 25.12	11- 1-63	19	168		94.7	Non-explosive proof injector and macerated chamber	Failed

[redacted]

[redacted]

TABLE II.- TOTAL TESTS CONDUCTED ON "PRESENT" DESIGN - Continued

85 Pound Gemini

<u>Specification MDC</u>

Calibration + Cape	16 sec
MDC	131 sec + 123 sec SS
Steady State	270 sec

Unit number	Test date	Actual burn time			NC*/Isp (percent)	Configuration (if different from production S/C 2)	Results
		Calibration	MDC	SS			
85# FW 2B 001	8-12-63	24	131		87	1.1 momentum ratio injector commercial material, low temperature glass	Forward firing MDC
85 lb. FW 2A 001	8-15-63	13	131		84	1.1 momentum ratio injector one piece macerated body, one piece liner, low temperature wrap encapsulated throat	Forward firing MDC
85 lb. FW 2B 002	8-22-63	24	131		90.3	Low temperature glass	Forward firing MDC
85 lb. FW 2C 001	10- 1-63	20	131	149	89.8		Successful MDC + SS life no P_c decay
85 lb. FW 2C 002	10-21-63	9 + 6	215		91		1,000° F. shell temperature at 11th pulse of new number 1 Fwd and Aft MDC
85 lb. FW 2A 002	10-24-63	9 + 6	315		84.4	1.1 momentum ratio injector, one piece macerated, one piece liner, low temperature glass	Ablative body failed from injector on 27th pulse of number 1 Fwd and Aft MDC
85 lb. FW 2C 003	11-13-63	19 + 28.8	298				Repetitive forward firing, MDC's completed MDC twice and failed 36 seconds into third.
85 lb. FW 2C 004	11-18-63	10 + 6	131	124.3	90	Button oxidizer manifold	Successful MDC at SS life. Lost altitude after 100 sec of MDC.

[redacted]

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TABLE II.- TOTAL TESTS CONDUCTED ON "PRESENT" DESIGN - Continued

100 Pound Gemini

2 Day Specification MDC	
Location	Location
Aft 304.5 sec MDC* +235.5 sec SS	Vertical up 157.0 sec MDC* +383.0 sec SS
Lateral left 110.0 sec MDC* +230.0 sec SS	Vertical down 264.0 sec MDC* +276.0 sec SS
Lateral right 258.0 sec MDC* +282.0 sec SS	

*Includes 10 sec calib., 6 sec. cape time, or 540 sec SS

Unit number	Test date	Actual burn time			NC*/Isp (percent)	Configuration (if different from production S/C 2)	Results
		Calibration	MDC	SS			
100 WH 001	7-11-63			162	96	1.6 momentum ratio and M/R .0225 oxidizer holes	Steady state to failure
100 lb. FW 2A 001	8- 1-63	36			85.1	1.1 momentum ratio at 1.6 M/R one piece macerated body, one piece liner, encapsulated throat	Injector button leak
100 lb. FW 2A 002	8- 7-63	35	248		85	1.1 momentum ratio injector, one piece macerated body, one piece liner, encapsulated throat	Vertical down MDC
100 lb. WH 002	8- 8-63			343	96	1.6 momentum ratio injector, .0225 oxidizer holes	Steady state failure
100 lb. FW 2B 001	8- 9-63	21	248		88	1.1 momentum ratio injector, commercial material, low temperature glass wrap	Vertical down MDC
100 lb. WH injector	8-10-63		602		95	1.4 momentum ratio injector, .0225 oxidizer holes, .0210 fuel holes	Steady state duration
100 lb. WH injector	8-10-63		600		94	1.4 momentum ratio injector, .024 oxidizer holes, .0225 fuel holes	Steady state duration
100 lb. BC 001	8-13-63				94.5		M/R survey
100 lb. BC 002	8-17-63				91.4		M/R survey
100 lb. BC 003	8-17-63				91		M/R survey

[redacted]

TABLE II.- TOTAL TESTS CONDUCTED ON "PRESENT" DESIGN - Concluded.

100 Pound Gemini

Unit number	Test date	Actual burn time			NC*/Isp (percent)	Configuration (if different from production S/C 2)	Results
		Calibration	MDC	SS			
10 lb. BC 001	8-21-63				93.4		M/R survey C*bias of 91.4 to 93.4 percent between CTL III and CTL IV
100 lb. FW, 2B 002	8-22-63	21	248		91.2	Low temperature glass	Vertical down MDC
100 lb. BC 2A 002	8-24-63					1.1 Momentum ratio injector	Oxidizer button relieved on 4th attempt. Horizontal and chilled
100 lb. FW 2B 003	8-25-63	24	242		92.2	Low temperature glass	Lateral right MDC. Throat cracked badly
100 lb. BC plug 001	8-31-63				89.2	Plug manifold has rounded oxidizer entrance	M/R survey
100 lb. FW 2B 004	9-10-63	24	197		91.4	Low temperature glass	Glass failure after 197 seconds of firing on aft MDC
100 lb. BC plug 002	9-13-63				93.4		M/R survey; Plug injector of release design
100 lb. FW, 2C 001	9-17-63	19.2	288.5	80	91.5		Failed. Throat eroded
100 lb. FW 2C 001	9-23-63			100	91.5		Steady state to burn through above throat
100 lb. FW 2B 005	9-24-63			534	90	Low temperature glass	Steady state to 13 percent P_c decay. No thrust decay; cracked throat
100 lb. FW 2D 001	10-3-63	34	288.5	227.4	92	Burke ring at the joint welded to shell	Steady state to burn through above throat at 202 seconds, 16 percent P_c decay
100 lb. FW 2C 002	10-8-63	34	288.5	227	90.2		Steady state to burn through above throat at 173 seconds, 50 percent P_c decay
100 lb. FW 2A 003	10-17-63	18		540	85	1.1 momentum ratio injector, one piece macerated body, one piece liner, low temperature glass	No P_c decay

TABLE III.- TCA TECHNICAL STATUS SUMMARY

New Requirements to Demonstrate				Present SCD Requirements			Accomplishments		
Life Under Nominal Cond.	Operating Information And Capability Tests	Design Information Tests	Component	Life	F	I_s	Life	F	I_s
			TCA						
Demonstrated	None Conducted	None Conducted	25 Lb RCS	137 Sec *MDC 162 Sec **SS	23 ±5 percent	266	147 MDC 162 SS	23.5	270-276
570 Sec (New MDC)*** Req'd. Not Demonstrated	None Conducted	None Conducted	25 Lb OAMS	232 Sec MDC	23 ±5 percent	272	165 MDC	23.4	272-286
100 Lb*** 755 Sec (New MDC)*** Req'd. Not Demonstrated	None Conducted	None Conducted	85 Lb OAMS	131 Sec MDC +139 Sec SS	79	286	131 MDC +139 SS	80	286-290
755 Sec (New MDC)*** Req'd. On Aft And One Lateral Not Demonstrated	None Conducted	None Conducted	100 Lb OAMS	288.5 Sec MDC +240 SS	94.5	286	288.5 MDC +173 SS	95	286-290

*MDC denotes "Mission Duty Cycle" operation.

**SS denotes "Steady State" (continuous burning) operation.

***New MDC has more severe duty cycle with no steady state runs. One engine per location is assumed in the above times. The time is reduced per TCA for duplicate engine installation from 755 sec to 550 sec.

TABLE IV.- COMPONENT PACKAGES DEVELOPMENT TEST STATUS

PACKAGE	STATUS			
	Complete	Almost Complete	Partially Complete	No tests (or unsuccessful)
"A"				
a. Forging	X			
b. Manual valve	X			
c. Pressure transducer	X			
d. Filter	X			
e. Cartridge valve	X			
f. Assembly		X		
"B"				
a. Machined body	X			
b. Manual valves		X		
c. Pressure transducer	X			
d. Check valves	X			
e. Relief valves	X			
f. Burst diaphragm	X			
g. Filter	X			
h. Assembly			X	

TABLE IV.- COMPONENT PACKAGES DEVELOPMENT TEST STATUS - Continued

PACKAGE	STATUS			
	Complete	Almost Complete	Partially Complete	No tests (or unsuccessful)
"C" and "D"				
a. Machined body			X	
b. Manual valve		X		
c. Filter	X			
d. Cartridge valve	X			
e. Assembly			X	
"E"				
a. Normally-open cartridge valve	X			
b. Normally-closed cartridge valve	X			
c. Pressure switch	X			
d. Solenoid valve			X	
e. Filter	X			
f. Manual valve	X			
g. Assembly				X

TABLE IV.- COMPONENT PACKAGES DEVELOPMENT TEST STATUS - Continued

PACKAGE	STATUS			
	Complete	Almost Complete	Partially Complete	No tests (or unsuccessful)
Pressure regulator		X		
RCS fuel tank				
a. Bladder		X		
b. Standpipe	X			
c. External tank	X			
d. Assembly		X		
OAMS fuel tank				
a. Bladder		X		
b. Standpipe	X			
c. External tank	X			
d. Assembly		X		
RCS oxidizer tank				
a. Bladder		X		
b. Standpipe	X			
c. External tank	X			
d. Assembly		X		
OAMS oxidizer tank				
a. Bladder		X		
b. Standpipe	X			
c. External tank	X			

TABLE IV.- COMPONENT PACKAGES DEVELOPMENT TEST STATUS - Concluded

PACKAGE	STATUS			
	Complete	Almost Complete	Partially Complete	No tests (or unsuccessful)
d. Assembly		X		
Motor valves			X	
Pressure-temperature indicator	X			
Braze fittings	X			
RCS and OAMS Pressurant tank		X		
Cartridge valves C and D	X			
A	X			
E (normally open)	X			

TABLE V.- AGE DELIVERY STATUS

Equipment	Manufacturer	Qty Req'd	Qty Del'd	Qty Avail for Del
1. Fuel servicing unit	Hamilton-Standard Division	2	1	1
2. Oxidizer servicing unit	"	2	0	0
3. Flushing unit fuel purge	"	2	0	0
4. Flushing unit oxidizer purge	"	2	0	1
5. Propulsion system checkout unit	Rocketdyne Division	3	2	1
6. Propulsion system control unit	"	6	2	1
7. Propulsion system checkout adapter kit	Rocketdyne Division	3 sets	2 sets	1 set
8. Propulsion components PIA console	"	Delivery	(of the 2 units)	is complete
9. Propulsion components checkout adapter kit	"	Delivery	(of the 2 units)	is complete
10. Fuel metering unit	"	2	1	0
11. Oxidizer metering unit	"	2	1	0
12. Nitrogen pressurization unit	"	6	4	0

TABLE V.- AGE DELIVERY STATUS - Concluded

Equipment	Manufacturer	Qty Req'd	Qty Del'd	Qty Avail for Del
13. Helium pressurization unit	"	6	4	0
14. RCS disposal system	"	4	2	0
15. OAMS disposal system	"	2	1	1
16. Propellant servicing adapter kit	"	4	1	0

Design

Thrust Chamber Assemblies. - A re-evaluation of the OAMS duty cycles by McDonnell Aircraft Corporation has resulted in an increased life requirement for all OAMS TCA's. This has compounded the TCA problem since the present duty cycle requirements have not been demonstrated under specification conditions on the 25-pound and 100-pound TCA's.

To meet the new requirements on the 100-pound TCA, Rocketdyne is lowering *c efficiency from 92-94 percent to 85-87 percent. The life of the 85-pound TCA is to be brought up to the 100-pound TCA limit by duplicating the chamber segment of the 100-pound TCA. Plans for the 25-pound engine call for an increase in chamber diameter to 3.75 inches and a reduction in *c efficiency from 93-94 percent to 88 percent (use of the conical splash plate injector). Other changes under consideration by Rocketdyne are the use of asbestos or 6° orientated refrasil cloth in the chamber billet or perhaps a regeneratively cooled ablative chamber. In addition, it will not be too surprising if changes to the throat insert are required because the additional times will impose more stringent conditions thus causing erosion and cracking. Some evidence of this has been observed in recent tests.

Some changes to the injector have been incorporated as a consequence of propellant pre-mixing within the injector orifices as discussed in the previous report. This problem has been resolved by reconfiguring the injector manifold to provide additional strength and to reduce propellant volumes. Afterwards, approximately two more months were lost while incorporating additional modifications to the injector passages to resolve a resulting high rejection rate (up to 100 percent).

The only other modification to the TCA's that was incorporated during this period was a change in the fiberglass wrap from one which maintained structural integrity to 500° F to one which holds its strength to 800° F. The "high-temperature" wrap feature resulted from loss of the external wrap strength during firing pulse cycles which allowed enough heat to soak through the chamber to permit separation of the chamber billet and injector fingers prior to total engine charring. Thus, in this failure mode, the engine failed prior to consuming its useful life. Since this change, no additional failures of this nature have been experienced.

System. - McDonnell Aircraft Corporation has initiated an analysis of alternate engine arrangements using existing TCA's, plus other configurations that would require relatively simple TCA changes thus producing the required life. Under one configuration studied, two engines would be utilized where the life requirement exceeds the delivered life per TCA, namely, in the forward, aft, and a vertical location. Since part of the long life requirement of the 25-pound OAMS TCA's results from counteracting the moment produced by the 100-pound vertical engine, a ninth attitude engine appropriately located would reduce the 25-pound TCA total life requirement. Since the missions for spacecraft 2 and 3 place relatively simple demands on the OAMS, McDonnell Aircraft Corporation determined that the life demonstrated on the present TCA's will be adequate for these two missions.

No design changes have been incorporated into the RCS TCA's due to its successful test program to date.

Components.- Two design changes have been incorporated in the following:

a. The "C" and "D" component package housings are being changed from castings to machined pieces.

b. The shaft seal of the manual valves of all control packages were changed from a split teflon O-ring to an omniseal.

Development Testing

Thrust Chamber Assemblies.- All tests which have been reported to Gemini Program Office during this reporting period are tabulated in table II, along with pertinent data concerning the tests. As will be noted from the table, very little testing occurred during November 1963. Rocketdyne did not feel obligated to test during this period since the duty cycles were being revised by McDonnell Aircraft Corporation. Considerable effort on analyzing and predicting performance of the small ablative engine was expended by Rocketdyne, so that great confidence exists at Rocketdyne on their ability to meet the new duty cycles.

Specific knowledge on the remaining over-all program is unavailable. It is the Gemini Program Office's understanding that the test scope of the research and development program is being reduced, but the extent is not known.

Table III summarizes the status of all TCA's. Rocketdyne considers that the insufficient life for the 25-pound and 100-pound OAMS TCA's pulse performance demonstration, and excess skin temperatures are the remaining engine technical problems to be resolved.

Components.- The test status of all components is presented in table IV.

System Testing

No tests were conducted during this reporting period as a result of thrust chamber unavailability. Although two flightweight systems, one each of the RCS and OAMS, have been assembled, initiation of testing is pending engine availability. System analysis constitutes the prime effort of this group at Rocketdyne. Thus, system tests which remain to be conducted are unchanged from the previous report.

Qualification Testing

No qualification tests have been conducted during this period. However, test plans are being prepared by Rocketdyne and are being reviewed by McDonnell Aircraft Corporation. None are approved at the present time.

AGE

All aerospace ground equipment (AGE) for Spacecraft Systems Test and pre-installation acceptance has been delivered. Approximately 45 percent of the required AGE for Cape Kennedy has been delivered and about 20 percent has been delivered to the pad. Delivery of all units should be complete by the end of the next status reporting period. The present delivery status is shown in table V.

PYROTECHNICS

A number of spacecraft changes have imposed new requirements on several of the pyrotechnic devices, thus requiring redesign and additional development testing. The new requirement for the addition of a drogue parachute in the landing system has led to the initiation of a development program for a drogue mortar. Redesign of the landing gear components to allow underwater functioning was completed. Redesign has also overcome out-of-tolerance time delays for horizon scanner release. Weight increases in the seat system have required redesign of the seat-ejector rocket to increase its thrust.

A high rejection rate on the cartridges for the OAMS and reentry control system valves has led to their redesign.

Spacecraft thermodynamics studies have indicated that the shaped charges may be subjected to temperatures which could cause the decomposition of their explosives. As a result of these studies, the shaped charges will be redesigned to use the high-temperature-resistant explosive, "Dipan". Developmental testing of the shaped charges using the new loading density, lower-brisance "Dipan" has begun. Development of the hatch actuator for the paraglider configuration was initiated. This design will allow manual release of the latch. Financial difficulties of the actuator vendor, who is also the vendor for the emergency docking release and the docking bar assembly, have led to development and production delays. The financial problems have been overcome and the conduct of these developments has resumed.

The tubing cutter-sealers are now meeting specification leakage requirements through use of increased tube-wall thickness.

Reliability assurance tests have begun on the Z 100.75 separation assembly, rendezvous and recovery separation assembly, guillotines, and mild detonating fuse initiation system.

Initiation of qualification testing of the horizon scanner fairing release, pyrotechnic switches, and landing-gear-door jettison system await delivery of parts.

LANDING AND RECOVERY SYSTEMS

Parachute Recovery System

On September 3, 1963, the qualification drop test program of the Gemini Parachute Recovery System was suspended to permit the incorporation of a high-altitude stabilization parachute into the recovery system. Incorporation of the stabilization parachute was deemed necessary to insure spacecraft stability in the event of a malfunction in the electronics associated with the automatic stabilization system and also to permit dumping of the RCS propellants prior to deployment of the main recovery parachute. Preliminary design studies have been completed and the detail design is underway. The sequence of operation of the revised recovery system will be as follows:

1. Deployment of the stabilization parachute at 50,000-foot altitude by the astronaut.

2. Release of the stabilization parachute at 10,600-foot altitude by the astronaut. This action deploys the 18.3-foot pilot parachute by means of a lanyard between the stabilization parachute riser and the pilot parachute deployment bag. After deployment of the pilot parachute, the stabilization parachute remains permanently attached to the apex of the pilot parachute.

3. Two and one-half seconds after the stabilization parachute release, the rendezvous and recovery section is separated from the spacecraft which, in turn, allows the deployment of the 84.2-foot main recovery parachute.

4. Three and one-half seconds after the rendezvous and recovery section separates, the 18.3-foot pilot parachute disreefs slowing the descent rate of the rendezvous and recovery section and minimizing the possibility of contact between the rendezvous and recovery section and the 84.2-foot parachute.

5. Ten seconds after 84.2-foot parachute deployment, disreef occurs, slowing the spacecraft to a descent rate of approximately 30 feet per second (corrected to sea level).

6. After 84.2-foot parachute disreef, the astronaut initiates single point release.

7. Twenty-two seconds after initiation of single point release, the release actuates and the spacecraft is reoriented to the 35° nose-above-the-horizontal attitude. This attitude minimizes the impact accelerations

and eliminates the need of impact attenuation devices for water landings.

8. After impact the astronaut disconnects the 84.2-foot parachute through the use of a pyrotechnic-operated disconnect.

Present schedules indicate that the incorporation of the stabilization parachute will not be accomplished until spacecraft 3. It is anticipated that the present recovery system will have to be used for spacecraft 2. A drop test program has been formulated to develop the stabilization parachute and to qualify the revised recovery system. The program is to be accomplished in three phases. Phase I will develop the lanyard deployment of the 18.3-foot pilot parachute by the permanently attached stabilization parachute. This phase will use boilerplate 5 as a test vehicle. Tests are scheduled to begin the first week of January 1964 and to continue into February 1964. Phase II will develop the stabilization parachute. From these tests, the reefing parameters for the parachute will be determined and the structural integrity of the parachute demonstrated. An instrumented weight bomb (PTV) will be used as the test vehicle for this phase. Testing for this phase is scheduled to begin about March 1, 1964, and be completed in August 1964. Phase III will be composed of complete-system drops and will be used to qualify the recovery system. Static article 7 will be used as the test vehicle and will contain a production recovery system. This phase of testing should begin in June 1964 and be completed in October 1964.

If the present recovery system (minus drogue parachute) is used on spacecraft 2, the qualification of that system will be resumed. Three drops are presently being planned, using static article 7, to complete qualification of the system. These drops should begin in February 1964 and be completed by the end of March 1964.

Paraglider Parachute Recovery System

The first of two inflight tests, using a Gemini boilerplate vehicle, to demonstrate the adequacy of modifications to the paraglider parachute recovery system was conducted at El Centro, California, on November 12, 1963. This test verified wind tunnel results concerning the relocation of the drogue parachute attachment and the incorporation of the impact-attenuation pad within the vehicle contours. The boilerplate, with the drogue parachute deployed, demonstrated adequate stability during the test and all equipment was recovered in satisfactory condition. The final test is scheduled for the first week in December 1963. This should complete the qualification of the paraglider parachute recovery system.

Paraglider Landing System

Half-Scale Tow Tests.- Ground tow testing at Edwards Air Force Base, using the half-scale boilerplate vehicle, was completed by the Flight Research Center on October 15, 1963. A total of 180 tests were made with the last 45 tow runs being conducted during this reporting period. Of the latter, 12 runs were made using the CH-46A helicopter; the remainder were made using a special test automobile as the towing vehicle. These runs were conducted to investigate vehicle lift-off characteristics, helicopter tow techniques, and the effects of wing bending during high speed tows. Vehicle attitude under initial conditions of -10° and 19° had no appreciable influence on the lift-off characteristics. No helicopter downwash problems were encountered with the technique developed for this type of tow. And the keel bending, as measured by inclinometers, was correlated with data obtained during half-scale and full-scale wind tunnel tests conducted at Ames Research Center.

Tow Test Vehicles (TTV).- A design engineering inspection (DEI) and hardware review were held at North American Aviation, Space and Information Systems Division, on September 27, 1963. A total of 33 Request for Alteration (RFA's) was submitted. Of these, 24 were placed in Category I (mandatory), 3 in Category II (study) and 6 were rejected by the board.

All applicable RFA items were incorporated on TTV 1 and manufacturing and assembly of the vehicle were completed during this reporting period. The vehicle was transported to Edwards Air Force Base on November 26, 1963, preparatory to commencing the flight test program. TTV 2 is running approximately one month behind TTV 1. The main structure was removed from the assembly jig on October 16, 1963. Parts shortages, notably in the Paraglider Control Actuation (PCA) System, may cause schedule slippage.

Ground tow tests of the TTV 1 (without wing) are scheduled to start during the first half of December 1963. The first manned flight is expected prior to the end of January pending results of full-scale wind tunnel tests of the wing and availability of a flight-qualified PCA from Vickers, Inc.

Full-Scale Test Vehicle (FSTV).- Fabrication and assembly of the FSTV's have been completed and all DEI items have been worked off. FSTV 2 should complete a combined systems test and a ground dynamic wing deployment during the first week of December 1963. It is planned to ship this vehicle to Edwards Air Force Base immediately following the wing deployment. The first inflight deployment is anticipated during the last half of December 1963. FSTV 1 is approximately ten working days behind FSTV 2.

Half-Scale Development Tests.- A series of drops of a half-scale wing and vehicle was begun during the reporting period at MSC. These tests are being conducted as an in-house investigation into potential problem areas, independent of North American Aviation's efforts, during the deployment phase of the paraglider. Basic aerodynamic parameters and qualitative stability characteristics are being obtained. The first drop, conducted over Galveston Bay, on November 14, 1963, indicated satisfactory stability of the test vehicle with the wing in the inverted "U" condition of deployment. Additional tests are planned for the month of December 1963 to study the deployment transition from the "U" condition to the "L" condition to steady state glide.

Prototype Wings.- Fabrication of prototype wings on the soft tooling was discontinued after completion of wings nos. 201 and 202. Wing no. 203 was not completed because of an excessive number of discrepancies, and the parts were relegated to test samples. The improved hard tooling was completed by the end of September 1963 and wings nos. 204 and 205 were fabricated with this tooling. Wing no. 201 was used in the initial full-scale test in the Ames Research Center wind tunnel. Wing no. 202 was used for packing tests and will be used for FSTV dynamic sequencing ground tests. Present plans are to use wing no. 204 for initial FSTV drops and wing no. 205 for initial TTV flights. Burst test specimens of the keel-spreader bar and boom-spreader bar burst at 50.6 psi and 35.0 psi, respectively. Wing no. 206 is in the final stages of fabrication.

Paraglider Interface.- A separate addendum to the paraglider interface meeting minutes was created to define action items, problem areas, and incompatibilities between the Gemini paraglider design program and items developed to support the existing North American Aviation paraglider research and development program.

McDonnell Aircraft Corporation initiated a design effort on the location and installation of the Gemini paraglider trim controls. The control schematic portion of a McDonnell Aircraft Corporation drawing for static article 2 was reviewed by North American Aviation and McDonnell Aircraft Corporation, and basic agreement was reached on the interconnection of the trim pots, reel position pots, and hand controller pots.

McDonnell Aircraft Corporation transmitted a document (no. 233-K-383), Listing of Weights, Centers-of-Gravity and Radius of Gyration for Paraglider System Components, to North American Aviation. North American Aviation transmitted thermal conductivity coefficients for the packed wing to McDonnell Aircraft Corporation for inclusion in their thermal analysis of the paraglider installation.

The majority of the government furnished equipment (GFE) to be provided to North American Aviation for the paraglider research and development program has been shipped. McDonnell Aircraft Corporation was notified of the revised GFE requirements resulting from the Gemini Program Office decision to eliminate the retrofit of the full-scale test vehicles (FSTV) to the Gemini configuration.

The paraglider contractor's weight status reports for the months of September and October 1963 were transmitted to the spacecraft contractor for incorporation into the spacecraft weight statements.

The paraglider interface meetings were curtailed as a result of the Gemini Program Office decision to concentrate on the paraglider research and development program. Minimum interface coordination will be maintained and interface meetings called on an "as required" basis.

ENVIRONMENTAL CONTROL SYSTEM (ECS)

System development testing at AiResearch has been completed without any significant problem areas. Dynamic and environmental qualification testing has started. Temperature-altitude qualification testing is scheduled to start during the next reporting period. Delays have been encountered from problems in first article manufacture and component redesigns.

Boilerplate 2, at McDonnell Aircraft Corporation, is in manufacturing buildup to install the complete ECS. Testing during the next reporting period will include a 2-day manned run, and a 14-day unmanned run. Manned and unmanned high-altitude ejection tests on the egress kit will also be made. The boilerplate will be shipped to MSC at the completion of the above tests.

Several changes have been made to the ECS during recent months. The coolant fluid was changed from OS 139 to MSC 198 to reduce system pressure drop and therefore power consumption during low-heat-load conditions. A 53-cubic-inch reservoir has been added to each coolant loop. Launch heating studies indicated a need for additional reservoir volume to allow for coolant expansion. The 53-cubic-inch size was chosen to utilize the same internal components as the existing reservoir. Spacecraft volume restrictions precluded enlargement of the existing reservoir without significant installation redesign. The outlet duct of the launch cooling heat exchanger has been modified to circulate hot coolant around the duct, thus maintaining the duct walls above freezing temperatures. Water dumping tests conducted at AiResearch indicated potential freeze up during liquid dump operation.

CO_2 Partial Pressure Sensor

The production status of the CO_2 sensors is summarized in table VI. The units delivered to McDonnell Aircraft Corporation are considered flight units unless the qualification tests indicate that modifications are required.

Completion of qualification tests has been delayed two months because of failures in the mission simulation test. Temperature, altitude, O_2 atmosphere, and pressure tests have been successfully completed. The sensor has failed the mission simulation test two times because of filter water absorption and inadequate burn-in time of the units. Failure of the sensor was characterized by a shift in zero point with no loss of sensitivity. Corrective action consists of longer burn-in time for units and the addition of a water filter. Remaining qualification tests are acceleration, vibration, shock, acoustic noise, RFI, low temperature, salt spray, and mission simulation.

Lion Research has been given the go-ahead to develop a fully transistorized amplifier, which if successful, will replace the present hybrid amplifier. The development of this amplifier is scheduled for completion in March 1964. McDonnell Aircraft Corporation has been directed to provide for each manned spacecraft, a "blow tube" through which the sensor can be checked by the astronaut. Since exhaled breath has a CO_2 content of approximately 35 mm hg, this would provide a full-scale deflection of the display meter. The zero point may be checked by letting oxygen flow through the tube.

TABLE VI.- CO_2 PARTIAL PRESSURE SENSOR STATUS

Estimated qualification test completion	Production prototypes		Production unit	
	Total	Del'd	Total	Del'd
January 1964	5	5	14	4

PRESSURE SUIT

The final evaluation of the G2C prototype suit was conducted during September and October 1963. Astronaut evaluation in the Gemini engineering mockup at McDonnell Aircraft Corporation indicated that most of the previous fit-problems had been corrected. Basic mobility in the suit was satisfactory, although a few isolated pressure points caused discomfort which could not be tolerated for long term wear. In view of the fit problems which have occurred, final fittings will be made at the David Clark Company prior to delivery of all future suits.

Several problems were encountered in the helmet and visor design. Modifications have been directed to eliminate cracking of the visor, to reduce the visor actuating forces, and to provide a positive latch for the visor in the closed position. The interference between the seat backboard and the helmet which was reported previously, was checked and confirmed. The spacecraft contractor was directed to modify the backboard contour slightly to eliminate the interference. To preclude further interference problems, the helmet contour and neck ring diameter were frozen at the present size and external configuration.

Evaluation of the electrical and electronic compatibility of the pressure suit communications and biomedical equipment in the compatibility test unit was satisfactory. An evaluation of the compatibility of the suit with the environmental control system in boilerplate 2 was also satisfactory. Oxygen flow, cooling, and ventilation were satisfactory in all portions of the suit except the gloves. The wrist disconnect rings are being redesigned to incorporate integral vent ports. Improved glove ventilation is expected.

In evaluating the suit flow characteristics, it was established that the present location of the pressure sensor for the suit pressure regulator could cause a negative pressure in the suit in comparison with cabin pressure. This condition is not compatible with the suit design and would cause excessive pressure drop and leakage into the suit from the cabin. To preclude this condition, the environmental control system operating procedures are being revised to leave the cabin recirculation valve open during normal orbit operations. This mode of operation will also minimize the likelihood of CO_2 buildup in the suit.

A prototype outer coverall incorporating an integrated parachute harness and integrated life vest was evaluated. Integration of the harness required the addition of leg and torso strap adjustment buckles which compromised the fit of the harness and caused discomfort. Since the present fitted harness is acceptable, no further effort on the integrated harness is planned at this time. The integrated life vest was not entirely satisfactory, but the basic concept is favored as the best means for providing personal flotation. A life vest which can be worn continuously is being developed by the Crew Systems Division. Once a satisfactory design is achieved, the vest will be integrated into the suit, if possible.

Deliveries of the G2C training suits are now in process. Suits for the parachute jump tests and the final ejection seat development sled tests have been delivered. The first two astronaut training suits are ready for the final fittings with delivery expected in early December 1963. The remainder of the astronaut training suits are scheduled for delivery in December 1963 and January 1964. These delivery schedules are compatible with present program requirements.

GUIDANCE AND CONTROL SYSTEM

ATTITUDE AND CONTROL MANEUVER ELECTRONICS (ACME)

During this reporting period, the Aerospace Ground Equipment (AGE) delivered in support of the ACME systems were the pre-installation acceptance (PIA) test console and spacecraft systems test console, together with supporting adapters and test boxes. The delivery of the ACME system for spacecraft 2 and the compatibility test unit were completed. Two units are continuing in the qualification program. During vibration tests on qualification unit 1, the mounting bolt (Calfax fasteners) for the ACE and OAME packages failed. McDonnell Aircraft Corporation and Honeywell are designing several fixes and hope to have a design released by mid-December 1963. Units of the ACME systems already delivered will continue in test until an appropriate retrofit schedule can be established.

During this period, the acceptance tester used in-house at Honeywell has been out of service since September 17, 1963. During this period all modifications and design improvements are being incorporated into the production AGE. Low-temperature tests on qualification unit 1 were completed on November 9, 1963. The vibration tests were started the following week and the ACE and OAME packages failed during test calibration period. Rate gyro and power inverter packages did not exhibit any vibration problems. In qualification unit 2, the electrical and electronic interference tests have started and will be completed prior to December 21, 1963.

The compatibility test unit tests on ACME at McDonnell Aircraft Corporation have been completed. Flight ACME packages for incorporation in the paraglider control system were shipped to North American Aviation for use in the flight test vehicle.

INERTIAL GUIDANCE SYSTEM

Computer

The third engineering prototype delivered to McDonnell Aircraft Corporation for use in the compatibility test unit tests uncovered a number of noise and spacecraft grounding problems. A rewiring of the compatibility test unit and the electronic systems test unit to represent spacecraft wiring more closely is being accomplished. This will allow additional engineering testing to overcome integration problems prior to the start of spacecraft systems test (SST). The no. 4 IGS for spacecraft 2, incorporating the flight configuration computer, was shipped to McDonnell Aircraft Corp., on November 29, 1963. Computer no. 5 has undergone extensive vibration testing and a number of vibration problems have been uncovered. Failures have been isolated to the area of the cannon connectors and the solder connections to connectors. A reallocation of computer delivery schedules has been accomplished providing for an early updating of IBM configuration control unit with the later version computer system to provide IBM with a system to check out engineering problems and flight hardware acceptance procedures. Two computer test consoles (AGE equipment) were delivered during the month of November 1963. Temperature environmental tests will be started on the exploratory qualification unit during the next two weeks.

Inertial Measuring Unit

The production platform no. 1 for spacecraft 2 SST, IGS (no. 4), was shipped October 24, 1963. Testing on the redesigned power supply unit incorporating improved regulators, input power isolation, and separate gimbal readout power excitation have been accomplished at McDonnell Aircraft Corporation on the compatibility test unit. As a result of these tests, a final design for the production power supplies has been established. After completion of these tests at Honeywell, the IMU system was shipped to IBM for integration into IGS no. 4. Production platform no. 5 vibration tests are continuing in an effort to reduce transmissibility to the inner gimbal. During systems acceptance tests, excessive gimbal oscillations have been observed and were caused by interaction of the gyro excitation and high-frequency gimbal control loops. The design fix consisting of a notch filter has been accomplished and is scheduled for all flight units. Delivery of rotary components and the improved slip rings continued to have a critical effect on deliveries. Recovery is expected during the month of December 1963. The overstress electronics production platform no. 4 started testing November 11, 1963.

GUIDANCE AND CONTROL

Horizon Sensors

During this reporting period, vibration testing of engineering and production horizon sensors identified excessive vibration amplification between mounts and positor head. The positor head failed during these vibration tests because of excessive translational motion. A design fix, incorporating snubbers to restrain lateral motion for the positor head, has been incorporated. Testing to determine suitability of these fixes is underway. Delivery of horizon sensors is limited because of the inadequate module production rate and the insufficient number of alinement stations. A program to provide additional personnel in critical areas and diversification of additional capital equipment from other programs is being pursued.

Rendezvous Radar

The first production prototype radar, which is allocated for the compatibility test unit (CTU), was scheduled for delivery in October 1963. However, because of design problems, the delivery date was delayed to January 1964. The major problems encountered after assembly and the action taken are listed in table VII.

TABLE VII.- MAJOR PROBLEMS AND ACTION TAKEN ON RENDEZVOUS RADAR

Unit	Failure	Action Taken
1. Radar video package	Fake triggering due to inadequate grounding	Redesign at three modules
2. Radar digital package	Marginal case of triggering on noise	Redesign of one module
3. Radar coaxial cabling	Antennas not properly phased	Develop new cable lengths
4. Radar AFC	AGE wiring caused AFC inconsistencies	Rerouted AGE cabling
5. Radar angle encoder	Digital angle readouts were incorrect	Returned units to vendor for new commutators

Printed circuit boards have had a serious effect on the delivery of two qualification test radars and the spacecraft 3 radar. The Westinghouse Electric Company boards manufactured for these units could not be used because of quality control problems, delaminated circuitry, and separation of the copper in the plated-through hole. Westinghouse Electric Company has now subcontracted the plated-through hole printed circuit boards to Electro Laboratory. Electro Laboratory encountered more difficulty than they had planned in making satisfactory silk screens from the Westinghouse Electric Company negatives. The spacing between conductors on a finished board was below MIL-STD-275 requirements because of excessive growth of copper on the printed circuits during the copper plating process. Westinghouse Electric Company has reworked and trimmed all of the black and white masters. Production of the new boards has now been resumed by Electro Laboratory.

Radio frequency microwave absorbent material was added to the radar ground plane in order to reduce the antenna cross-coupling problem (excessive radar angle accuracy errors). However, this added material creates a serious thermal problem because radar temperature control must now depend upon thermal capacity instead of radiation to space. Preliminary test results indicate that radar operating time will be limited to less than the required six hours because of this change. Methods of extending this operating time are being studied. Some possibilities under consideration are: (1) increasing allowable component temperatures; (2) reduce the required length of operating time; (3) reduce the amount of ground plane area that must be covered with absorbent; and (4) determine if other solutions exist for the antenna cross-coupling problem.

In addition to the above problem, a radar cold temperature problem is under evaluation. As described in the last report, the radar may reach a temperature of -65° F at the end of the maximum time in the non-operating mode, assuming a long exposure to the space environment prior to the start of the rendezvous phase of the mission. Cold tests have verified that the radar will not meet specification requirements immediately after being subjected to -65° F for 42 hours. Satisfactory operation was obtained after warming the radar ground plane to approximately -6° F. This cold temperature problem can be solved either by utilizing an auxiliary internal heater, or by monitoring radar temperature and turning it on a sufficient length of time prior to rendezvous to allow for warmup. Both of these solutions cause a penalty of input power. At this time, it has not been decided which method will be used.

Simulated Gemini-Agena docked mode radio frequency tests have shown that the present Gemini-Agena command link is unusable from a separation of approximately 7 feet down to the docked configuration.

The cause of this is the high VSWR in this area. It was determined that the radar would require extensive modifications for the command link to operate reliably in this close proximity to the Agena. Also, a rendezvous mission could not be completed if the radar command link failed. Because of these items, it has been determined that the radar command link shall not be required to accomplish final docking as previously planned.

The Westinghouse Electric Company anechoic chamber was evaluated during this reporting period. It does not appear that the chamber will be able to measure the radar to a 3 milliradian accuracy without having a correction factor for reflected radio frequency waves. The actual correction factor can only be determined by comparison with an outdoor range test. This outdoor range test is now planned to be performed at New Mexico State University during February 1964. This testing had to be delayed because of the CTU radar delivery slippage. It is also planned to perform dynamic testing (flight test) of the radar and transponder at White Sands Missile Range starting in March 1964. The purpose of the flight test is to determine the dynamic tracking capability of the radar.

Table VIII shows the status of the radar system hardware as of the end of this reporting period.

EJECTION SEAT SYSTEM

Most of the activity on the ejection seat system during this period was in the design and manufacturing area. Some tests were completed, but the majority were delayed until the design changes can be incorporated into the system. A large portion of the effort in this period was on center of gravity shift determination and two of the dynamic tests were in this area. Tests were also made on the harness and ballute system.

A design study was initiated to determine the feasibility of jettisoning the backboard and egress kit prior to landing on the parachute. The study is to be completed during December 1963.

Other design changes which have been incorporated into the system are a 5-second delay in ballute deployment and lowering of the ballute release altitude from 17,000 feet to 11,500 feet. These changes were made to reduce the initial load and length of unstabilized free fall.

TABLE VIII.- HARDWARE STATUS SUMMARY

Unit	Qual. Test Est. Comp. Date	Engr. Proto.		Prod. Proto.		Prod.		Remarks
		Total	Del.	Total	Del.	Total	Del.	
Radar	June 1964	3	3	4	0	12	0	Radar for S/C 3 del. est. 4-3-64
Transponder	June 1964	3	3	4	0	14	0	Trans. for S/C 3 del. est. 1-3-64
Indicator	Feb 1964	5	5	0	0	17	0	
Encoder	May 1964	1	0	2	0	10	0	
Rend. Eval. Pod	Not Tested	0	0	1	0	2	0	Transponder in Pod is qualitested
Dipole Ant., Agena	Feb 1964	3	3	3	0	7	0	
Ant. Mast, Agena	March 1964	1	1	3	0	9	0	
Spiral Ant., Agena	Feb 1964	6	6	6	0	14	0	

Delays in delivery of vendor components and printed circuit board problems caused delays in qualification testing and delivery of hardware to McDonnell Aircraft.

One of the main reasons for the delay in testing is the manufacture of the new egress kit. Complexity in the machining operation has made the completion of the first set of kits more than one month behind schedule. Sled development tests are delayed until completion of the first two kits.

Harness Tests.- Six tests were completed on the parachute harness at El Centro, California. These tests are required before the system is jumped by live subjects in the scheduled parachute qualification tests. The harness was taken to 150 percent of the design load with complete satisfactory results.

Center of Gravity Shift.- Data reduction on the human slump tests has been completed and the final report is being written. Preliminary indications are that the slump is well within the tolerance of the system.

Two free-flight tests were completed at Rocket Power, Inc., in Mesa, Arizona. The tests were made to confirm predicted trajectories with the thrust vector on the outer fringes of the allowable window. The tests were made from ground level with no separation of seat-dummy combination attempted. Both tests were successful.

Ballute Tests.- The first human subject test of the ballute was made at El Centro, California, on November 22, 1963. The jumper left the aircraft with the predeployed ballute at a pressure altitude of 12,500 feet, and at an indicated air speed of 110 knots. The jumper was programed for a free fall of 30 seconds, but released the ballute prematurely after 13-15 seconds when he experienced moderate spin characteristics (maximum rate 50 rpm). The program is scheduled for completion by the end of December 1963.

CREW STATION INTEGRATION

The design effort by McDonnell Aircraft Corporation was completed on essentially all the crew station request for alterations (RFA's) generated in the mock-up reviews of June and July 1963. Many of these modifications have been released for production. The remaining items are being incorporated into the Gemini engineering mock-up for astronaut evaluation in mid-December 1963.

The most significant problem is the basic crew station design, at this time, is the lack of stowage space for additional equipment on long duration missions. A preliminary review of the experimental equipment, which has been proposed for use on the long duration flights, indicates the desire for several large items to be carried in the cockpit. There is no cockpit space available for stowing these large items on the flights which require substantial quantities of food. Modifications to existing stowage provisions are being considered. Unless they are found to be feasible, accommodation of large items of experimental equipment in the cockpit will be impossible for the longer missions.

A docking simulation program was conducted in the Langley Research Center television docking simulator in September 1963 to evaluate the Gemini docking controls and displays. The attitude hand controller, the flight director and attitude indicator, and the range/range rate indicator were found to be satisfactory for the approach and docking maneuver. However, the translational hand control was unsatisfactory because of erratic control slop. McDonnell Aircraft Corporation has designed a new translational hand control which will be evaluated in the translation and docking trainer as well as in a later phase of the Langley Research Center docking simulation program. Alinement of the Gemini spacecraft with the Agena target was found to be well within the capabilities of the astronauts for simulated daylight docking. For dark-side docking, alinement was more difficult because of the lack of visual alinement cues. Langley Research Center has developed several lighting aids for use as visual references during the docking maneuver, and these lighting aids will be evaluated in subsequent phases of the Langley Research Center program.

McDonnell Aircraft Corporation and the Flight Crew Support Division have conducted studies to determine the adequacy of the out-the-window view of the horizon as an attitude reference for reentry. The results to date indicate that the view of the horizon does provide an adequate reference for controlling spacecraft attitude during normal and abort reentries. This use of the out-the-window visual reference procedure would be necessary in case of failure of the inertial measuring unit in flight. Simulation programs are being established at Ames Research Center and at McDonnell Aircraft Corporation to determine how accurately the astronaut can control reentry attitude by visual reference to the horizon. These simulations will also include evaluation of window markings for attitude reference and evaluation of the errors in the point of touchdown when using horizon viewing for reentry attitude control. These simulations are scheduled to commence in December 1963.

The first draft of the Gemini Flight Operations Handbook has been published by MSC and is now being reviewed. The first section, which consists of system descriptions and schematic diagrams, was completed by the Flight Operations Division in October 1963. The second section, which consists of operating procedures and check lists, was completed by the Flight Crew Support Division in early November 1963. McDonnell Aircraft Corporation is providing technical data and support to these two divisions who are coordinating the handbook as an MSC publication. The same handbook is intended for use by the flight controllers and the flight crew as the primary reference document on the Gemini spacecraft.

EXTRAVEHICULAR OPERATIONS

Requests for proposals on the Gemini extravehicular life support package were sent out in October 1963. The system being contemplated includes a high-pressure gaseous oxygen supply bottle plus suitable regulators and valves for control of the oxygen flow, which is an open loop. This system will provide the necessary life support for the initial extravehicular operations using a hardline tether and limiting outside operations to 10-15 minutes. The proposals were received on November 25, 1963, and the evaluation should be completed in December 1963.

WATER SYSTEM

Redesign of the drinking water nozzle by the Whirlpool Corporation has resulted in a pistol-type water dispenser. Evaluation of the pistol dispenser has shown it to be much easier to handle and operate than the previous design. All operations can now be accomplished with a single hand. The spacecraft mounting provisions for the water dispenser were being finalized at the close of this reporting period.

URINE SYSTEM

The design efforts to obtain a new urine transport system have been only partially successful to date. Whirlpool Corporation has been pursuing two system concepts: one employing static pressure differential and the other employing a centrifugal pump. The primary problem which remains unsolved is the elimination of oxygen which becomes entrapped in the system. The present spacecraft interface will not permit oxygen flow into the evaporator. Whirlpool Corporation is stationing a resident engineer at McDonnell Aircraft Corporation to facilitate interface coordination until the present problems are resolved. In addition, McDonnell Aircraft Corporation has been directed to initiate a backup effort to develop an alternate urine collection and disposal system. The Crew Systems Division is also reviewing the Mercury MA-9 urine system as a basis for possible further development and application to the Gemini spacecraft.

Whirlpool Corporation is presently fabricating working prototypes of their two system concepts, which now appear feasible. The prototype hardware is scheduled for delivery to MSC for evaluation by mid-December 1963. Production release is being withheld pending a satisfactory system demonstration.

COMMUNICATIONS SYSTEM

Voice Communications

Design approval tests are complete for the voice control center (VCC) and the transmitter-receiver (T/R) units except for the overstress tests on the UHF T/R which are now scheduled for January 1964. The delay was because of the replacement of a temperature sensitive feed-through capacitor which caused low power output. No other developmental problems remain and deliveries should proceed according to schedule. The T/R cases are to be gold plated for heat transfer purposes.

A vendor has been selected and design is virtually complete for the astronaut's light weight headset. This item is stowed in a pocket on the leg of the suit and plugs into a quick disconnect plug near the neck ring where the helmet is removed. Prototypes are expected for approval during December 1963.

Hardware delivery status is shown in tables IX and X.

[redacted]

TABLE IX.- VOICE COMMUNICATIONS HARDWARE DELIVERY STATUS

Unit	Engineering prototypes		Production prototypes		Production units	
	Total	Del'd.	Total	Del'd.	Total	Del'd.
UHF/TR	5	5	5	5	32	1
HF/TR	4	4	5	5	33	4
VCC	4	4	4	4	16	3
Helmet mic	-	-	10	10	100	30
Voice recorder	Vendor has not been selected.					
Headset (earphones and wraparound mic)	Delivery early 1964				20	0
UHF test benches	Delivered October 1963			1	1	1
HF/VCC test benches	Estimated delivery Dec. 1963				11	0

[redacted]

TABLE X.- VOICE COMMUNICATIONS HARDWARE DELIVERY STATUS AND ALLOCATIONS

Item	Spacecraft 2	Spacecraft 3A	Spacecraft 3
UHF T/R	Jan. 1964	Jan. 1964	Feb. 1964
HF T/R	Delivered	Delivered	Dec. 1963
VCC	Delivered	Delivered	Delivered

Antenna System

Some flight hardware has been received for all antenna and multiplexer systems. A few minor technical problems are still under study. Structural redesign of the rendezvous and reentry module may cause redesign of the UHF stub. Several concepts are being considered. Antenna system hardware delivery status is shown in table XI.

[redacted]

TABLE XI.- ANTENNA SYSTEM HARDWARE DELIVERY STATUS

Unit	Estimated Q. T.[1] completion	Engineering prototypes		Production prototypes		Production units		Manufacturer
		Total	Del'd.	Total	Del'd.	Total	Del'd.	
HF ANT	Completed	2	2	3	3	16	3	DeHavilland
UHF-reentry module								
Descent	Dec. 63	1	1	1	1	18	2	McDonnell Aircraft Corporation
Recovery	Dec. 63	1	1	1	1	18	2	McDonnell Aircraft Corporation
Stub	Dec. 63	1	1	1	1	18	3	McDonnell Aircraft Corporation
UHF-adapter (2) whips	Completed	4	4	4	2	35	4	DeHavilland
C-slot	Completed	1	1	1	1	18	4	Rantec
S-slot	Completed	1	1	1	1	18	4	Rantec
C-helics	Completed	2	2	4	4	16	3	Radcom
Quadri-plexer	Completed	2	2	3	3	16	4	Rantec
Diplexer	Completed	2	2	2	2	18	5	Rantec
Coax switches	Completed	8	8	8	7	98	81	Transco

[1] Q. T. - Qualification Test (1963)

[redacted]

Time Reference System

Scheduled hardware deliveries were delayed by several failures of a resistor used extensively in the electronic and event timer. It was judged necessary to replace this metal film resistor with a high-reliability component from a different supplier. The delay was because of the short supply of the new resistor, retrofitting of some modules, and requalification. Other quality control problems have caused minor delays. Table XII summarizes the hardware status.

Estimated hardware delivery dates are shown in Table XIII.

[redacted]

TABLE XII.- TRS HARDWARE STATUS

Unit	Estimated Q. T.[1] completion	Engineering prototypes		Production prototypes		Production units		Manufacturer
		Total	Del.	Total	Del.	Total	Del.	
Electronic	Mar. 1964	1	1	5	4	14	0	McDonnell Aircraft Corporation
Event timer	Mar. 1964	1	1	3	3	14	0	McDonnell Aircraft Corporation
Greenwich Mean Time Clock	Dec. 1963	1	1	2	2	14	0	Aerosonic
Pre-Installation acceptance test console	-	-	-	-	-	2	2	McDonnell Aircraft Corporation
Factory test equip.	-	-	-	-	-	2	2	McDonnell Aircraft Corporation

[1] Q. T. - Qualification Tests

TABLE XIII.- TRS HARDWARE DELIVERY STATUS

Item	Spacecraft 2	Spacecraft 3A	Spacecraft 3
Electronic timer	Jan 1964	Dec 1963	Jan 1964
Event timer	Jan 1964	Dec 1963	Jan 1964
GMT clock	Dec 1963	Dec 1963	Jan 1964

[redacted]

Digital Command System

DCS hardware delivery status is summarized in table XIV.

TABLE XIV.- SPACECRAFT SYSTEMS

Unit	Allocation	Delivery	
		Date	Estimated
Engr. prototype - No. 1	Electronic systems test unit	Nov. 1962	
Engr. prototype - No. 2	Flyover	Jan. 1963	
Prod. prototype - No. 1	Flyover	May 1963	
Prod. prototype - No. 2	Compatibility test unit	May 1963	
Prod. prototype - No. 3	Qual. test	June 1963	
Prod. prototype - No. 4	Qual. test	June 1963	
Prod. unit - No. 1	Spacecraft 2	Nov. 1963	
Prod. unit - No. 2	Spacecraft 3A		Dec. 1963
Prod. unit - No. 3	Spacecraft 3		Dec. 1963
Prod. unit - No. 4	Spacecraft systems test spare		Jan. 1964
Prod. unit - Nos. 5-18	Spacecraft spares		Jan. 1964 - May 1965

The delivery of the first few production units slipped approximately two months because of qualification test vibration failures, and purchased parts material analysis record keeping. These problems have been solved, and all qualification and reliability assurance tests have now been successfully completed and the qualification tests report forwarded.

All digital command/AGE items have passed pre-delivery acceptance tests and have been shipped.

Effective from spacecraft 4 and on, McDonnell Aircraft Corporation is required to provide the necessary spacecraft wiring flexibility to permit rapid changes of real-time command coding between flights.

Acquisition Aid Beacon

Production of acquisition aid beacons for spacecrafts 3 and 4 has been delayed because one of the transistor vendors changed the outside dimensions of the transistors used in the beacon. This vendor has now agreed to produce enough transistors with the original dimensions to finish beacon production. Delivery of beacons for spacecrafts 3 and 4 is scheduled in December 1963. Table XV summarizes the acquisition aid beacon hardware status.

TABLE XV.- ACQUISITION AID BEACON HARDWARE STATUS

Qualification test completion date	Production prototypes		Production unit	
	Total	Del'd.	Total	Del'd.
Oct. 1963	4	4	12	4

Radar Beacons

Correction of the overstressed capacitor has been accomplished by a redesign of the power supply of the S- and C-band beacons. The retrofitted C-band beacon for spacecraft 1 has been received at Cape Kennedy. All beacons, other than the prototypes to be used in the compatibility test unit, have been shipped back to ACF for retrofit. The compatibility test unit will be retrofitted at a later date. Reliability assurance tests on the beacons are scheduled to begin in December 1963. A summary of the status of the radar beacons is shown in table XVI.

TABLE XVI.- RADAR BEACON HARDWARE DELIVERY STATUS

System	Qual. test completion	Engineering prototypes		Production prototypes		Production unit	
		Total	Del'd.	Total	Del'd.	Total	Del'd.
C-band	July 1963	2	2	3	3	14	5
S-band	July 1963	2	2	3	3	13	5

Beacon AGE units have been delivered to McDonnell Aircraft Corporation and Cape Kennedy.

UHF Recovery Beacon

Qualification tests of the UHF recovery beacon have been completed. McDonnell Aircraft Corporation is now analyzing the numerous failures encountered during tests to determine the necessary revisions required in the design of the beacon. The case for the beacon must be redesigned to alleviate seal breakage encountered during vibration and altitude tests. The beacon failed the radio interference portion of the qualification tests. McDonnell Aircraft Corporation is now studying ways to reduce radiation emitting from the beacon. The most optimistic date for delivery of a flight qualified UHF recovery beacon is February 1964.

A summary of the status of the UHF recovery beacon is shown in table XVII.

TABLE XVII.- UHF RECOVERY BEACON HARDWARE STATUS

Qualification test completion	Engineering prototypes		Production prototypes		Production unit	
	Total	Del'd.	Total	Del'd.	Total	Del'd.
Nov. 1963	2	2	2	1	15	0

INSTRUMENTATION SYSTEM

Deliveries of the pulse-code modulation system built by Electro-Mechanical Research have slipped because of recurring problems in the in-house test set; low-level accuracy not within specification limit of ±2 bits error, and a NASA requirement to X-ray all flight system transistors. Electro-Mechanical Research has been able to correct most of the in-house test set problems by design changes and more prudent routing and shielding of cables. A plan of parallel efforts has produced better selective shielding in the programer wiring matrix, an improved low-level amplifier clamp, and a constant current source for the low-level amplifier. Since all systems built up to system 6 will have non-specification control drawing parts and not be allowed to fly, NASA felt that further efforts to reduce the error in these systems would not be fruitful. McDonnell Aircraft Corporation was directed to accept systems 4, 5, and 6 with 95 percent of the low-level data channels within ±6 bits error and the remaining 5 percent of the channels to be within ±8 bits error. Systems 4, 5, and 6 are now scheduled for delivery to McDonnell Aircraft Corporation in December 1963. Delivery status of all instrumentation system equipment is given in table XVIII.

The Gemini PCM tape recorder built by RCA successfully passed the sinusoidal vibration specification after the following design modifications were made:

1. Vibration isolation by means of ball joint suspension

2. Modified cover and case

3. Laminated motor board (laminating modified from earlier methods)

4. Dual capstan tape drive system

5. Modified tape path

6. Moving pressure belt

7. New tuning fork

8. Optimization of bearing loading reels, converters, rollers, etc.

9. Modification of speed converter

10. Increased shaft sizes in drive mechanism

11. New detection system employing the one-shot multivibrator

12. Brass counterweight added in area of record/reproduce heads (to dampen vibration effects)

Many of these fixes had been tried back in June 1963, but optimization of these and the additional changes were needed. Since the additional mechanical-type fixes reduce the bit jitter so much that 10 percent bit jitter will never occur and ground stations will have no difficulty in remaining locked on, the "single-shot" playback detection scheme can be used. The use of the "single-shot" multivibrator-type of detection system allows bit jitter in excess of that permitted by the previously used phase-locked oscillator (PLO) detection system, and guarantees no data dropouts since detection is on a bit-by-bit basis.

The RCA built telemetry transmitters failed during the vibration test portion of the qualification tests. Three failures occurred during the qualification-test vibration portion. These were:

1. A transistor failure which was found to be the result of poor transistor fabrication (not in vibration sensitive area).

2. A trimmer capacitor whose failure cannot positively be attributed to vibration, since it is on the fringe of the vibration sensitive area.

3. A fixed capacitor lead was broken by vibration.

With the occurrence of these problems, RCA mapped the entire transmitter for vibration sensitive areas and no others were found to exist. There has been a major redesign of the production prototype transmitters to enable them to withstand a thermal surge without out-of-specification performance. Additional shielding baffles were added which strengthen many areas in the transmitter so that they are vibration stiffened. Since the three transmitters in spacecraft 1 are engineering models not having these strengthened areas, a very good chance exists for vibration problems to occur in the engineering models.

The approach taken by RCA has been to selectively foam pot areas watching for dielectric and performance losses.

RCA recommended a combination of foam potting and the addition of metallic studs fastened to the cover to dampen the vibration sensitive "X12" board to the effects of vibration. Retrofit of the nine production prototypes transmitters will be complete on December 23, 1963, and qualification tests will then resume. The first three retrofitted transmitters are due the first week in December 1963 and will be sent to

[redacted]

spacecraft 1 at Cape Kennedy. In qualification testing the following tests have not been run:

1. Vibration
2. Shock
3. Acceleration
4. Acoustic noise
5. Salt water immersion
6. Humidity

The following qualification tests had been completed but must now be re-examined as to their validity with the retrofitted transmitters:

1. Altitude-temperature endurance
2. High temperature
3. Low temperature
4. Thermal surge
5. Radio frequency interference

The final three equipment racks for the -1 PCM telemetry ground checkout station were received by McDonnell Aircraft Corporation in November 1963. Problems which have arisen in the CDC printer for the -3 station are being corrected by the Control Data Corp., and acceptance of this station is expected to commence on December 9, 1963.

Delivery of the first PCM test set has slipped until April 1, 1964. This slip has resulted from the necessity of incorporating "cross-bar switching" in order to reduce voltage drops across switch contacts and line noise effects to less than 70 microvolts.

The early instrumentation equipment delivery status is given in table XVIII. Equipment has either been received or the expected delivery date is shown.

[redacted]

TABLE XVIII.- INSTRUMENTATION EQUIPMENT DELIVERY STATUS

Item	CIMU	CTU	Spacecraft		
			2	3A	3
DC- to DC converters	Rec'd.	Rec'd.	Rec'd.	Feb. 64	Jan. 64
Signal conditioners	Rec'd.	Rec'd.	Dec. 63	Mar. 64	Jan. 64
Accelerometers	Rec'd.	Rec'd.	Dec. 63	Dec. 63	Dec. 63
Pressure transducers	Rec'd.	Rec'd.	Dec. 63	Dec. 63	Dec. 63
Temperature sensors	Rec'd.	Rec'd.	Dec. 63	Feb. 64	Feb. 64
Transmitters	Rec'd.	Rec'd.	Dec. 63	Dec. 63	Jan. 64
Tape recorder	Rec'd.	Rec'd.	Jan. 64	Feb. 64	Mar. 64
PCM multiplexer-encoder	Rec'd.	Rec'd.	*Feb. 64 Interim in Dec. 63	Dec. 63	*Mar. 64 Interim in Dec. 63

*Flight system

The qualification test status of component parts of the instrumentation system is given in table XIX.

TABLE XIX.- INSTRUMENTATION SYSTEM QUALIFICATION TEST STATUS

Item	Supplier	Qual. Test	
		Start	Complete
Linear accelerometer	Gulton Industries	5-7-63	6-28-63
Pressure transducer	Fairchild Controls		
Dash 1, 5		4-1-63	4-25-63
Dash 31, 35, 37, 39		11-22-63	1-15-64
Dash 41, 45, 47		11-22-63	1-17-64
Resistive element temperature sensors	Rosemont Eng's.		
Dash 9, 13, 19, 47		4-1-63	7-1-63
Dash 3, 11, 31		6-1-63	8-30-63
Dash 7, 21, 37		6-15-63	8-30-63
Dash 83		12-1-63	2-15-64
Signal conditioners	McDonnell Aircraft Corporation, Flight Test Division	12-1-63	3-1-64
DC-to-DC converter	McDonnell Aircraft Corporation	10-15-63	12-15-64
PCM multiplexer encoder	Electro-Mechanical Research Corporation	2-4-64	4-25-64
Telemetry transmitters	Radio Corporation of America	Restart 12-23-64	1-25-64
PCM tape recorder	Radio Corporation of America	2-10-64	5-10-64

Astronaut Instrumentation

Evaluation of all prototype hardware, with the exception of the impedance pneumograph, has been completed. The results of this evaluation indicate the following changes are needed for flight hardware:

1. The output resistance of the blood pressure measuring system signal conditioner must be reduced from 5000 ohms to 1000 ohms.

2. The tape recorder recording time must be increased from 25 hours to a minimum of 72 hours because of the inflight changing of tape being so impractical.

Specifications are being prepared for flight hardware bioinstrumentation. Release of the specifications has been delayed awaiting development of a qualification test program for components located inside the pressure suit. Delivery of completed flight hardware bioinstrumentation harnesses is scheduled for June 1964.

POWER SUPPLIES

Fuel Cells

The initial eight stacks produced by General Electric have met acceptance standards. However, subsequent production has failed to yield any additional satisfactory stacks. The vendor is conducting an intensive investigation to determine the cause of poor performance of the production stacks. The assembly of any additional production stacks is being delayed until the cause of the poor performance is determined.

The eight stacks were assembled (together with one "preproduction" stack) into three test sections. Two of these sections are being used in McDonnell Aircraft Corporation power systems tests. The performance of these two stacks has dropped to almost minimum specification requirements in the initial 25 hours of testing. The third section has failed to meet pre-delivery acceptance requirements.

Preliminary studies indicate that purge-gas flow requirements can be met by the existing regulators. However, an additional regulator may be added for redundancy purposes. McDonnell Aircraft Corporation is also studying the feasibility of providing lower temperature coolant to the fuel cell. Tests of single cells show an approximate doubling in fuel cell life with a 20° F. lowering of the operating temperature.

The vendor is also investigating a redesign of the hydrogen side of the cells to provide positive purging of inerts and water. Design features under investigation include removal of the hydrogen side wicks; inclusion of purge tube restrictors so that a uniform pressure drop can be achieved which will force water out of the tube; and dams to direct the flow of the hydrogen across the cell. The first buildup containing these design modifications has accumulated more than 600 hours of within-specification operation, while utilizing coolant at a reduced temperature. "Wet proofing" of the cell with Teflon will also be tested to determine whether loss of the membrane active material can be reduced.

Incorporation of the aforementioned coolant system and fuel cell design modifications on initial spacecraft systems appears unlikely. However, these modifications will probably be made on later spacecraft to achieve the two-week mission requirements.

Studies have been initiated to reduce the preflight testing of fuel cells to achieve increased useful mission life.

The contract for analysis of fuel cell product water chemical and bacteria content has been placed with Ionics, Inc. of Cambridge, Massachusetts. However, testing has been delayed because of the lack of suitable production fuel cells.

Tests of the monitoring control unit (MCU) have shown it to meet basic specification requirements. However, the poor load sharing of stacks experienced thus far indicates that the MCU will not be able to determine the adequacy of fuel cell performance. All activity on the MCU program has been terminated.

Batteries

After reconsidering the specifications and tolerances on the titanium cases used in the batteries, McDonnell Aircraft Corporation directed Eagle-Picher to relax specific tolerances and welding specifications where it was legitimate to do so. With cases already fabricated, Eagle-Picher has delivered batteries to Cape Kennedy in support of spacecraft 1.

The spacecraft -7 and -9 main bus and squib batteries successfully completed all prequalification tests.

AERODYNAMIC TESTING

The following two aerodynamic tests were conducted during the reporting period.

Transonic Buffet Tests of Gemini-Titan II - The purpose of this test was to investigate the loads introduced into the Gemini Launch vehicle structure due to aerodynamic buffet. The test was conducted in September 1963 in the Ames Research Center's 14-ft. transonic wind tunnel. The Mach range investigated was from 0.6 through 1.14 at angles of attack of 0, 4, and 8 degrees. Preliminary analysis of the data indicate that the loads due to buffet are not excessive. However, since the variation of these loads with Mach number was not adequately investigated due to wind tunnel limitations, further testing at higher Mach numbers is required. Planning is in progress to conduct further tests in January 1964 to extend the buffet investigation Mach number range through the maximum dynamic pressure region.

Full-Scale Paraglider Test - The purposes of this test were to determine the aerodynamic characteristics of the full-scale wing, define the line rigging required for tow-test vehicle (TTV) flight, evaluate the effect of structural deflections on the aerodynamic characteristics, and define the "$q\alpha$" boundary for spreader-bar buckling. The test was conducted in October 1963 in the Ames Research Center's 40 × 80-ft. wind tunnel.

Initial data from the computer indicated that keel deflections were causing extreme effects on the basic aerodynamics as determined from the half-scale wind tunnel results, and that trim points could not be established with the rigging used. Consequently, investigations of wing rigging not previously included in the test plan were instituted. After completion of the test, errors in the data reduction equations were discovered and when corrected, the initial results were negated. However, as a result of the additional testing, insufficient data were obtained to define the line rigging for TTV flight and to satisfy all the test objectives. Consequently, a repeat test has been scheduled to begin December 3, 1963, to obtain the data required.

LAUNCH AND TARGET VEHICLES INTEGRATION

GEMINI LAUNCH VEHICLE (GLV)

GLV Schedule Review. - Schedule reviews were held to establish schedules and ground rules for the first three Gemini launch vehicles and spacecraft. Tentative schedules were established based on the following ground rules: No flight readiness firing (FRF) on GLV 1, 2, and 3; sequenced compatibility firing (SCF) on all three vehicles; extended electrical electronic interference (EEI) tests on GLV 1 and 2 but not on 3; and POGO fixes to be on all three vehicles. Turbopump assembly removal time not included.

Dates for GLV on the pad, SCF, spacecraft on the pad, and launch are being established and will be discussed further at a schedule review meeting on December 13, 1963.

Weight.- A spacecraft weight plotted against launch payload capability comparison indicates that the GLV will be capable of launching the first nine spacecraft. For missions 10 through 12, if a paraglider is used, a launch capability deficit of over 400 pounds is indicated. The 220-pound payload increase by GLV weight reduction is being formalized by Space Systems Division on a cost basis and will be implemented in the near future.

Longitudinal (POGO) Vibration Status.- Considerable progress was indicated in eliminating objectionable longitudinal oscillations. The lowest longitudinal vibration recorded to date was on the N-25. This vibration amounted to ±0.11g at a frequency of 13.2 cps at a station equivalent to the spacecraft station. The N-25 was the first vehicle to have fuel accumulators installed in addition to the oxidizer standpipe. This same configuration is planned for the N-29 flight.

Propulsion System Development.- Quite an extensive and detailed design review is being conducted at Aerojet-General Corp., and at Martin Company to improve the reliability of the various engine components and the overall performance of the power plant.

Propellant Tank Level Sensors.- EEI problems have been occurring with the Titan II Powertron sensors. Also erroneous signals have been experienced during Titan II flight. Three possibilities for a fix on the GLV exist:

1. Use the improved Powertron sensor for instrumentation purposes only.

2. Use the Bendix sensor which is being reviewed by Space Systems Division/Aerospace.

3. Eliminate the shutdown portion of the sensor or the entire low-level sensor and allow shutdown to occur by fuel or oxidizer depletion. The shutdown feature on the sensors has been eliminated on Titan II since the sixth flight. Fuel depletion shutdowns have occurred on

N-14, N-19, N-24, N-25, and N-27 without difficulty. A GLV payload increase capability of 163 pounds can be realized by elimination of sensor shutdown capability.

Engine Prevalves.- New prevalves are being considered for Stage I and II engine propellant lines effective with GLV 4 and on. These new prevalves will be nitrogen gas-operated instead of squib-operated and will be capable of being turned on and off without replacing the valve. Qualification testing on the new design man-rated prevalves will be required. Proposals are being evaluated for the new man-rated prevalve at this time. An Engineering Change Proposal is being submitted to SSD on this proposal. The use of the new design prevalves will result in a weight saving for the vehicle. With this configuration, only flight valves will be provided. Valves for ground use only will no longer be required.

The prevalves to be used on GLV 1, 2, and 3 will differ from Titan II prevalves in that the shearable diaphragm used on Titan II has been replaced by an O-ring seal. This O-ring seal will permit closing the valves after SCF and FRF without replacing the valve.

POGO Fuel Line Accumulator.- The accumulator design is being studied to eliminate friction and to improve its function in eliminating longitudinal oscillation in flight. A new gas-type torus-shaped accumulator, which is lighter in weight, is also being studied.

Second Stage Gas Generator.- The design for the second stage gas generator used on the Titan II has not proven satisfactory because of combustion chamber fluctuations in pressure and the possibilities of plugging of the multiple oxidizer-orifice injector as demonstrated on several flights. To correct this problem a single oxidizer-orifice design was used which was not satisfactory because of P_c fluctuations. A design, designated at MOD 7A has now been made, which Aerojet-General Corporation believes will be satisfactory. This redesign or rework uses four 0.0485" dia. orifices for oxidizer injection, which are about twice the size of the present orifices. This arrangement is known as the Toadstool or Oxidizer Splash Plate Design. Tests indicate that the design is as stable as the production design and has less chance of clogging.

Pending development of a suitable design of the gas generator, the interim policy consists of super cleaning. As a final check before launch, gas is discharged through the orifices and the pressure drop checked so accurately that one plugged orifice can be detected.

Before adoption on the GLV, the MOD 7A design will be flight tested on the Titan II.

[redacted]

<u>Turbo Pump Gearbox</u>.- In the gearbox investigation being carried on, the following steps are being taken to increase the operational life of the assembly.

1. Resonance evaluation is being made.

2. Gear tooth geometry is being investigated.

3. Deflection characteristics are being investigated.

4. Independent appraisals are being made by G. E. and Western Gear.

Six Stage I engine gearboxes are being tested to determine the suitability of the redesigned gears. The idler gear has a thicker web and rim and a black oxide is used as a protective coating. The new gear used a modified (vinco gear type) tooth profile instead of a standard tooth profile.

After reviews at Western Gear, five of the six gearboxes completed the 14 runs (two 200 second and twelve 165 second) at Aerojet with no difficulty. Two runs have been completed on the sixth gearbox with the remaining runs scheduled for completion by December 7, 1963. In addition, gearboxes 7 and 8 will be available for engine qualification tests about January 27, 1964.

Design improvement studies are being conducted by Western Gear and General Electric. In these studies, Western Gear is limited to the use of present basic design, whereas no restrictions have been imposed on the General Electric design.

VEHICLE DESTRUCT SYSTEM

<u>Destruct Initiator</u>.- Manufactured by Thiokol, Bristol, Pa., the new destruct initiator design was completed on December 1, 1963. Qualification tests are scheduled for completion on February 2, 1964.

Use of the old initiator is also being considered and will be tested. Ten units have been built without a short and ten units are being built with a short incorporated. Five of these latter ten have been built without a short and are presently being modified to include a short.

For GLV 1, it is planned to have three sets of qualified units at Cape Kennedy. This will include two vehicle-sets of new units and an additional set of the old design with and without a short incorporated.

[redacted]

HYDRAULIC SYSTEM

Tandem Actuator.- This unit has been redesigned to include a reinforced body. The actuator has demonstrated adequate strength except for the 5-position null switch. This switch failed during vibration testing. An inspection of the actuators which were used during firing tests at Aerojet is being made to determine the condition of the switch on those actuators. The failure is being analyzed to determine immediate action and the long range course of action.

FLIGHT CONTROL SYSTEM

Three Axes Reference System.- An improved bellows design will be incorporated into the Three Axes Reference System (TARS) HIG-4 gyros to provide a positive internal pressure on the gyro fill media throughout the ambient temperature range. Qualification test procedures have been submitted and approved for partial requalification testing. The scheduled delivery date for the first production unit with new large bellows is the first week in December 1963.

Autopilot: Autopilot production is frozen for GLV-3 and up until receipt of rate gyro systems manufactured under established cleanliness and contamination control and process control criteria. The new gyro systems will be incorporated in GLV 1 and 2.

Rate Gyro: A Stage II rate gyro exceeded hysteresis specification requirements as part of post-production monitor autopilot tests. Failure analysis on this gyro system indicated a loose microsyn end gimbal support bearing and foreign material on the gyro gimbal.

An engineering design audit has been initiated at the manufacturer towards implementing more cleanliness and contamination control during the manufacture of all future units. In addition, an industry survey is being conducted to determine the possibility of a second source for the Stage I and II rate gyro packages.

Adapter: Adapter qualification tests have been satisfactorily completed and the report of the qualification test results have been written.

Unit No. 1 (failure mode test) is being reworked by manufacturing for product monitor testing. Unit No. 2 (environmental life test) has completed product monitor tests. Reliability testing of these units is scheduled to start soon.

RADIO GUIDANCE SYSTEM

Launch Guidance Equations: Gemini program software effort included preliminary assembly and coding of the radio guidance equations for the A-1 computer. The T-15 minute routine was modified to be compatible with the A-1 computer logic. A new delivery schedule is in the process of being compiled reflecting the final A-1 computer equation program.

A-1 Computer: Gemini program hardware effort included the checkout, the acceptance test, and the delivery to the Burroughs Atlantic Missile Range Gemini Facility of the data exchange unit, the flight monitor recorder console, the test conductor console, the external signal junction box, the card storage, and the interconnecting cabling.

The MILGO data transmitter and receiver equipment used with the Gemini mission simulator will be delivered directly from the manufacture in mid-December 1963.

Guidance Switchover: A special presentation was given by SSD/Martin Company on the feasibility of modifying the GLV flight control system to provide the capability for flight crew lockout of the inertial guidance system (IGS) before or at any time during powered flight.

Based on the need for extensive modifications to airborne hardware and the small potential gained in mission success and crew safety since the change, NASA agreed that IGS lockout was not desirable. However, it was concluded that it might be desirable to investigate the feasibility of providing the capability of switching back to Stage II radio guidance system (RGS) at staging. SSD was requested to study the hardware implications involved in providing this capability and report the results at the Launch Guidance and Control Panel Meeting.

MISTRAM: A meeting was held at MSC to review MISTRAM for backup radio guidance, GO-NO-GO and IGS updates, and to consider SSD's response to an MSC TWX for the implementation of MISTRAM. Based on Air Force airborne and ground equipment support and the fact that NASA does not have the capability of implementing MISTRAM without the support of SSD, it was agreed not to implement MISTRAM for the reasons stated previously. The Gemini Program will use and depend on the operation of MOD III to provide the capability of radio guidance GO-NO-GO's and for three IGS updates.

General Electric MOD III: The testing of three 4-inch slot antennas to support the first Gemini launch has been completed at Pittsfield Ordnance Range. The constraints on pitch look angle for the MOD III system are currently being revised to reflect the new gain margin link calculations based on the results of the full-scale tests.

Evaluation of the isolated base plate mounts has resulted in a Stage II weight increase of 23 pounds. A weight reduction study effort is in process to reduce the weight of the base plate mounts.

ATLAS-AGENA

Because of previous problems with the Agena primary propulsion system (PPS) gas generator valve, Bell Aerosystems Company and Lockheed Missiles and Space Company continued maximum efforts on the development testing of the gas generator valve and on the paralled valve program. On November 15, 1963, a meeting was held at Bell Aerosystems Company where it was decided to use the new solenoid-type gas generator valves for the Gemini-Agena model 8247 PPS. This change in the engine design allows significant reductions in complexity as well as significant increases in reliability confidence. For example, the electronic monitor and control assembly used to pulse the latching mechanism of the old valve is no longer required and the turbine over-speed control system electronics are reduced more than 50 percent. Pre-flight rating test (PFRT) is now scheduled to start January 1964. Also, the use of this valve will not effect launch schedule. Work on the old, latching-type valve was discontinued in a manner which would allow rapid reactivation in the case of unforeseen problems with the new engine configuration.

During the week ending November 23, 1963, separation tests of the Gemini-Agena shroud were conducted by the contractor, Douglas Aircraft Corporation, at facilities in Tulsa, Oklahoma. This shroud protects the target docking adapter (TDA) during the launch of the target vehicle. Testing was conducted under simulated altitude conditions to demonstrate proper operation of the pyrotechnic devices and to show adequate clearance between the shroud and TDA during separation. The test program was successful. Fabrication of the flight shrouds as a group will now be completed and the units delivered in January 1964.

Development tests of the secondary propulsion system (SPS) have progressed slower than expected because of unforeseen problems. These difficulties which are bellows head binding, tank distortion, and bellow cracking, appear to have been resolved. Performance of the SPS has been very good during firing tests and the PFRT of the system is expected to begin in December 1963. This date, although late, will not affect launch schedules.

A decision was made to have all but the first, 5001, flight-type SPS shipped from Bell Aerosystems Company directly to Cape Kennedy. This is expected to greatly aid in protecting the units against handling damage and the problems noted above as well as provide significant cost savings. Responsibility for the systems will remain vested at Lockheed Missiles and Space Company, but the units will be accepted as flight-worthy at Bell Aerosystems Company.

After an exhaustive investigation involving NASA Headquarters and Lewis Research Center, it was determined to be in the best interests of NASA to procure a third Agena system checkout complex at Lockheed Missiles and Space Company, Sunnyvale, California. This third complex will be funded by the Gemini Program, but will be available to Lewis Research Center Agena programs on the basis of non-interference to Gemini. It is estimated that this complex will cost an additional 1.0 million dollars and it is scheduled to be ready for use in June 1964.

A decision was made in October 1963 to use a Motorola DPN-66 C-band beacon instead of developing a new Lockheed Missile and Space Company type VI beacon. This decision was based upon using a beacon which demonstrated reliability and a saving of 30 to 40 thousand dollars.

A study was started by Lockheed Missiles and Space Company to determine the cost and schedule effect on the command system by increasing the Agena command capabilities from 96 to 128 channels.

The method for checking the command system on the launch pad was finalized and Lockheed Missiles and Space Company was requested to implement the system which uses a pickup antenna in the vicinity of the launch vehicle.

The selection of a contractor to formalize the launch guidance equations for the Atlas-Agena was started.

Tentative ground rules were written by MSC regarding the Agena in-orbit maneuvers. These are to be used for Gemini rendezvous mission planning, establishment of flight control procedures, and formulation of the real-time computer program. An ascent error analysis for the Atlas-Agena was completed by the Agena Contractor. This will be used to further definitize MSC rendezvous mission planning procedures.

Changes were made to the Agena command system to add necessary spacecraft and ground commands to turn the TDA approach lights on and off, to dim the TDA status lights, and to select either the dipole or spiral L-band transponder antenna.

A review of the General Electric Company MOD III guidance equipment to be used on the Atlas launch vehicle was held with Space Systems Division. It was determined that the Gemini-Atlas will be using the same equipment as the Gemini Launch Vehicle including the new vibration- reducing base-mounting plates.

[redacted]

A study was initiated by the Agena contractor to determine the errors associated with pitch maneuvers in the Agena orbital plane. Consideration will be given to pitch maneuvers from +90° to -90°.

Requirements were established for the type of information and publications needed by Operations personnel. Lockheed Missiles and Space Company has been directed to revise the Operations Handbook and to augment other publications in order to satisfy the requirements.

Negotiations have started at Space Systems Division on completing the definitization of the Gemini-Agena development contract. These negotiations should be completed in January 1964.

A plan for the funding of the Atlas SLV-3 launch vehicle has been established with Space Systems Division.

Qualification test on the Pulse Code Modulation telemetry system and the programer and controller have been delayed until December 1963. The Agena contractor has stated that deliveries of flight hardware will not be affected.

LAUNCH COMPLEX (MODIFICATIONS)

COMPLEX 19

Construction progress on Complex 19 at the Atlantic Missile Range has been satisfactorily completed with activation and GLV erection taking place on October 28, 1963. However, some minor facilities construction is still to be completed by the Corps of Engineers. They are as follows:

a. Spacecraft power receptacles

b. Relocation of spacecraft shower

c. Installation of escape hatch in elevators

d. Replace nitrogen regulators in the test stand propellant purge system

e. Additional White Room platform

It is anticipated that the above items will be completed by December 15, 1963. In addition, facility test procedures are in process and will continue on a non-interference basis with GLV-1 checkout.

[redacted]

A plan to install the spacecraft cryogenic plumbing and cabling concurrently with the checkout of GLV-1 and other pad activity has been formulated. Engineering work to accomplish this plan has been started, although an implementation decision has not been made. The work would be accomplished on the third shift and on Saturdays and Sundays. This plan reduces the installation task from 10 weeks to 5 weeks which was originally scheduled to be done between Gemini Missions 1 and 2.

Significant Activity Highlights.- The following items are a summation of the complex 19 activities during this reporting period:

a. Complete set of facility "as built" drawings has been completed and furnished to Atlantic Missile Range.

b. Erector actuators controls have been modified for better reliability.

c. Tests were performed on the propellant vapor vent stacks. The results proved the vent stacks are capable of meeting requirements 10 percent greater than those in the design criteria.

d. Aerospace technical report on the erector indicated that the erector does not meet the design criteria about deflection in the raised and locked position. As a result the acceptable wind loads for Gemini Mission 1 must be reduced from 75 to 48 mph. Aerospace is continuing to study the problem and is awaiting data upon completion of wind tunnel tests to be made at Langley Research Center.

e. Martin will use an interim installation of AGE and landlines to obtain EEI measurements for GLV-1 checkout. A permanent installation will be used for GLV-2 and up.

f. The erector bridge crane structure was changed from a welded to a bolted structure because of poor quality welds.

g. Twenty-two captive seal ball valves were disassembled in the propellant system and were returned to the vendor for rework. The valves were experiencing a stick-on problem because of a galling process which took place after cycling the system.

COMPLEX 14

A Complex 14 Activation Phasing Group Meeting was held at the Atlantic Missile Range on October 30, 1963. A launch complex integrated conversion milestone schedule was reviewed and the following items are highlighted:

a. Launch test stand available, September 15, 1963

b. Mercury equipment removal completed, November 1, 1963

c. Air Force advertise and award, August 26 to October 1, 1963

d. Corps of Engineers facilities construction; start October 2, 1963, and complete June 1, 1964

e. AGE deliveries from November 1, 1963, to June 15, 1964

f. Complex validation; start June 1, 1964, and complete August 19, 1964

g. Complex readiness date, October 14, 1964

In addition, a Facility Working Group was established and will be chaired by the 6555th Air Force Facilities Division. It will be operated in the same manner as the Facility Working Group on Complex 19.

NETWORK INTEGRATION

PROGRAM REQUIREMENTS DOCUMENTS

Revision 4 of the program requirements document was distributed during this quarter. Revised sheets for the above document were sent to the Operations Support Office (OSO) at Atlantic Missile Range in the latter part of October 1963 for inclusion in Revision 5. Distribution of Revision 5 from the Atlantic Missile Range is expected approximately December 15, 1963. Revised sheets reflecting schedule and other requirement changes were sent to the OSO on December 2, 1963, for inclusion in Revision 6.

GROUND TRACKING NETWORK

Compatibility tests between the NASA PCM telemetry ground station and both the Gemini and the Agena Telemetry Systems were conducted on September 21, 22, and 23, 1963. The tests disclosed no incompatibilities between the ground station and either set of the spaceborne equipment. A complete report on these tests from Goddard Space Flight Center will be distributed in early December 1963.

Compatibility tests between the NASA digital command system modulator and the Gemini spacecraft digital command system, that were planned for the month of September 1963, were postponed because of scheduling problems. These tests will be accomplished during the first fly-by test of the digital command system equipment either at Wallops Island or over the Rose Knot Victor (RKV).

During the past several months, the Ground Systems Project Office (GSPO) has prepared the following documents:

1. Ground Operational Support System Telemetry Network Data Book
2. Ground Operational Support System Digital Command Network Data Book
3. Gemini Launch Data System Book

The documents were prepared to provide a method for maintaining technical control over the systems design and implementation of the various systems and subsystems within the ground network. In the preparation of these documents, the GSPO received inputs from the various MSC elements, including the Gemini Program Office (GPO). All GPO contractors having need for these documents are being placed on distribution (Space Systems Division, McDonnell Aircraft Corporation, Lockheed Missiles and Space Company, and Martin Company).

The Goddard Space Flight Center network implementation schedules have been deferred because of delays in receiving approval for facilities funding at Canary Island, Guaymas, Hawaii, and Texas. Additional slippage is anticipated on a day-by-day basis until funds become available.

DEFINITION OF GROUND NETWORK INTERFACES

For the purpose of further clarifying the "GE/Burroughs/NASA Interface" requirements, a letter was transmitted to AF/Space Systems Division on November 29, 1963. At the present time, it is GPO's understanding that there are no outstanding questions about the NASA-SSD interfaces.

The Telemetry Network Data Book, Digital Command Network Data Book, and the Launch Data System Data Book recently published by the GSPO define the major network interfaces with particular emphasis being placed on the IMCC/Network interfaces.

The desired completion date of December 1, 1963, for the telemetry interface between the Atlantic Missile Range equipment, Mission Control

Center, and GE/Burroughs has been changed to February 1, 1964. This delay was made possible by the schedule change of mission GT-1 launch from January to March 1964.

CREW TRAINING

The Gemini Part Task Trainer is operational with retrofire and reentry control tasks. It has been used approximately 15 hours during October and November 1963 by the astronauts for hand controller evaluation and retrofire training.

The flight crews received water survival training in conjunction with parachute training during this quarter. This training was conducted at Houston, Texas, with the exception of one day of training on water survival techniques supported by the Navy Water Safety and Survival School, Pensacola, Florida. The following paragraphs briefly describe each phase of the training:

a. Parachute Landing Fall – Ground School was conducted on the "prepare-to-land" position, touchdown, roll procedures and canopy securing. Supervised training in actual parachute landings was then accomplished with each pilot making five towed parachute landings; the first fully towed to a gentle landing and the remaining four were free descents.

b. Canopy Manipulation – This phase consisted of supervised training in canopy manipulation. Each pilot made three free descents in which programed turns and slips were executed.

c. Parachute Water Landing – Ground School at the Ellington swimming pool consisted of demonstrations, instruction and supervised practice in water impact and harness and equipment release in both conditions of being or not being dragged by the parachute using the Gemini harness and back-board.

d. Water Survival Techniques – The water survival techniques were conducted by Mr. Jack Martin, Chief Instructor of Water Safety and Survival School, U. S. Naval School of Preflight, Pensacola, Florida. This training consisted of pressure suit flotation, life raft boarding, underwater egress, parachute extrication, helicopter pick-up, parachute drag escape, and shroudline disentanglement. The training was completed in a one-day period. All the equipment necessary for this training was available in an enclosed training tank at Pensacola, Florida. The pilots went through underwater egress first in swimming suits and then went through each of the listed activities in a Gemini development pressure suit using, when appropriate, the Gemini harness and backboard.

e. Water Survival Academics - Dr. Donald Stullken of Flight Operations Division covered survival in the climatic and geographic areas overflown in the Gemini mission, physiological problems in sea survival (water, food, exposure, motion sickness), sea survival equipment and presented a movie, "Deep Sea Survival."

f. Parachute Water Landing - Supervised training in actual water landings was conducted with each pilot making descents into the water and completing water landing procedures.

g. Free Fall Technique - A briefing on the techniques of free fall stabilization and maneuvering concluded the parachute training program. Chief Warrant Officer Charles Laine (Project officer for the manned Gemini parachute system tests), El Centro, California, gave this briefing.

[redacted]

SIMULATORS AND TRAINERS

The checkout of Serial Number One Gemini Mission Simulator (GMS) was completed November 27, 1963. A unit approval test to demonstrate the hardware compatibility is scheduled for December 2 through 6, 1963. The computer program at Link in Binghamton, New York, is approximately 75 percent complete with a schedule completion date of December 21, 1963.

The complete GMS No. 1 is scheduled to arrive at Cape Kennedy on December 29, 1963, and be ready for acceptance on March 8, 1964. GMS No. 2 is scheduled to arrive at MSC, Houston on March 1, 1964, with acceptance testing on March 29, 1964.

The schedule for delivery and utilization of the docking trainer has been revised with some engineering tests being shifted to MSC, Houston. The original set-up and checkout at McDonnell Aircraft Corporation is requiring more time than anticipated with the overall completion now scheduled for June 7, 1964.

MSC is currently evaluating the engineering tests and may require that the latest-design maneuver controller be evaluated by the Astronauts prior to shipment from St. Louis, Mo.

The centrifuge trainer has been shipped from Johnsville to MSC-Houston and is being tied-in to the Mercury trainer for astronaut use in Houston.

MISSION PLANNING

Mission Planning Coordination

Gemini mission planning is being coordinated by monthly MSC panel meetings with representation from MSC organizations as follows:

a. Gemini Program Office

b. Flight Operations

c. Flight Crew Operations

Mission Documentation

Following is a list of documentation to be published for Gemini Flights. In general, these documents correspond to documents in the Mercury Project:

[redacted]

a. Program Instrumentation Document (PIRD)

b. Program Requirements Document (PRD)

c. Operations Requirements Document (ORD)

d. Data Acquisition Plan

e. Mission Rules

f. Flight Plan (applies to manned missions)

g. Mission Directive

h. Flight Operations Documentation

(1) Mission Procedures

(2) Preflight Working Papers

(3) Recovery Plans (preliminary recovery requirements dated Nov. 1, 63 has been forwarded to DOD)

(4) Simulations

(5) Operations Handbooks

Flight Planning

GT-1.- Detailed mission objectives and information for the first Gemini flight have been published in NASA Project Gemini Working Paper 5005, "Mission Directive for Gemini-Titan II Mission I GT-1", dated November 14, 1963. This flight will be an unmanned orbital flight launched on an azimuth of 72.0 degrees.

GT-1a.- This mission is a backup flight to GT-1. It is identical to GT-1 except that a boilerplate reentry module will be used instead of a flightweight reentry module.

GT-2.- The second Gemini mission will be an unmanned ballistic flight. This flight will carry all systems required to qualify the GLV and spacecraft for manned orbital flight. The ballistic trajectory was chosen to provide a maximum reentry-heating rate on the reentry module afterbody. A water landing is planned and spacecraft recovery is mandatory to a successful mission.

GT-3.- The third Gemini mission will be a manned three-orbit flight. The spacecraft will be launched on an azimuth of 72.0° so that the designated abort area at 16° west longitude and 27.456° north latitude (geodetic) will be included as a subsatellite point. After a "GO" decision to proceed on the second orbit, a rendezvous evaluation pod (REP) will be ejected from the spacecraft for a rendezvous evaluation exercise. Reentry will be initiated by the astronauts and the reentry flight path will be controlled by the spacecraft computer. The spacecraft will land in the Atlantic recovery area.

GT-4.- The fourth Gemini mission will be a medium-duration manned orbital flight. Power requirements may limit the mission duration to four days. The spacecraft will be launched at an azimuth of 90° into the 87-161 nautical mile reference Gemini ellipse. The spacecraft orbit will be circularized to 161 nautical miles at the second apogee. During maximum tracking coverage in the 12th to 18th orbits, a rendezvous exercise will be conducted with the REP to simulate Agena terminal rendezvous maneuvers. After completion of the rendezvous exercise, the spacecraft will continue in the 161-nautical mile circular orbit for the mission duration. Spacecraft reentry will be initiated by the astronauts. Controlled reentry and a water landing are planned.

GTA-5.- The fifth Gemini mission is the first of the rendezvous flights. The spacecraft and GLV capability for this flight will be the same as for missions GTA-7 through GTA-12 except that GTA-10 through GTA-12 will carry a paraglider landing system in place of the parachute system. First, the Agena vehicle will be launched into the circular 161-nautical mile orbit. Approximately 24 hours later, the Gemini spacecraft will be launched into the elliptical 87-161 nautical mile orbit. If large plane or phase changes are required, the Agena vehicle will be maneuvered after both vehicles are in orbit. If small changes are required, they can be provided by spacecraft maneuvers. Some plane change capability is provided by yaw-steering of the GLV. A radar-computer guidance system will be the primary mode of rendezvous for this flight. After completion of docking, postdocking maneuvers will be performed with the docked vehicle. Specified lifetime capability for the rendezvous configuration of the Gemini spacecraft is two days.

GT-6.- This is the long-duration Gemini flight. A flight of at least 7 days is required for support of Apollo missions. If this flight is less than 7 days, an additional long duration flight will be necessary. This flight will be launched at an azimuth of 90° into the 87-161 nautical mile ellipse. At first apogee the spacecraft OAMS will be used to circularize the orbit at 161 nautical miles.

GTA-7.- This is the second rendezvous development flight. The same flight sequence will be followed as on GTA-5. The radar-optical rendezvous mode will be primary for this flight. Appropriate onboard experiments will be carried. Postdocking maneuvers will be accomplished.

GTA-8.- This is the third rendezvous development flight. The mission for this flight is designed to evaluate pure optical guidance for rendezvous with the radar-optical and radar-computer modes as back-up. Postdocking maneuvers will be conducted.

GTA-9.- All Gemini rendezvous flights are rendezvous development flights, but the last four flights are designated rendezvous advancement flights because of the complexity of the missions planned. By the time of the GTA-9 flight, countdown and launch procedures should be developed to the point where the small launch window for the first pass of the Agena can be used. In this mission both vehicles would be counted-down simultaneously to ensure maximum readiness of both vehicles when the first vehicle (Agena) is launched. A 90-minute hold would be observed in the second vehicle (Gemini) count and the vehicle would be launched during the small launch window when the first vehicle passes over Cape Kennedy at the end of its first orbit.

GTA-10.- This rendezvous advancement mission will be designed to investigate thoroughly direct rendezvous with the target vehicle. Earlier flights are designed for the possibility of direct rendezvous if exact on-time launch is accomplished.

GTA-11.- This rendezvous advancement flight will simulate Apollo lunar excursion module orbits and maneuvers.

GTA-12.- This rendezvous advancement flight will provide investigation of dual rendezvous. After rendezvous with the Agena, the combined vehicle will further rendezvous with an already orbiting satellite. Orbits and launch windows will depend on the target satellite available, but operations and procedures will simulate Apollo lunar excursion module maneuvers, where possible. If an appropriate satellite is not available, dual rendezvous will be performed with an ejected capsule and Apollo Lunar excursion module abort maneuvers will be simulated in detail.

OPERATIONS, CHECKOUT, AND AGE

Spacecraft 1 completed spacecraft systems test (SST) during the month of September 1963 and a satisfactory "Roll-Out" inspection was conducted on October 1, 1963. On October 4, 1963, the spacecraft was shipped to Cape Kennedy where the pallet tests have now been completed and the spacecraft is currently undergoing assembled spacecraft testing in Hangar AF.

Compatibility Test Unit (CTU).- Several procedural and operational problems encountered during testing were corrected and proven by retest. The delivery of satisfactory systems for the CTU remains a major problem and causes test schedule slippage.

Pre-Installation Acceptance (PIA).- At the McDonnell Aircraft Corporation facility, interim operation of PIA equipment is underway in building 1. Plans are being formulated to move all PIA operations into the new building 101 during the month of December 1963, thus providing a centralized location for the PIA testing.

Spacecraft Systems Tests (SST).- SST facilities have been completed and the SST equipment is being progressively installed and calibrated. Spacecraft-to-junction-box cables and a junction box to test equipment cables are being delivered. Plans have been formulated to install these cables in conjunction with the planned spacecraft systems test operation of spacecraft 2.

AGE Status

Electronic Equipment.- The UHF beacon, computer, inertial measuring unit (IMU), radar, horizon sensor, and attitude indicator equipment have been accepted by McDonnell Aircraft Corporation and the equipment is now in operation.

Cryogenic Equipment.- The cryogenic gas converters have been tested and accepted by McDonnell Aircraft Corporation.

Hypergolic and Propulsion AGE.- All initial units of hypergolic and propulsion AGE from Hamilton-Standard and Rocketdyne have been tested and delivered to McDonnell Aircraft Corporation. The fortieth first article demonstration (FAD) test on this equipment will be conducted in conjunction with the compatibility tests unit static firing of the OAMS and reentry control system static firing.

Environmental Control System and Reactant Supply System PIA Consoles.- All AGE units of these two systems have been tested and accepted by McDonnell Aircraft Corporation, except the LH_2 bench. First article demonstration testing of the bench has slipped because of a shortage of spacecraft components needed to perform this test.

Fuel Cell AGE.- The initial set of the AGE for the fuel cell has been tested and accepted by McDonnell Aircraft Corporation. However, subsequent changes in the spacecraft requirements will require a redesign, considerable hardware changes, and additional testing.

RELIABILITY

A comprehensive review of the Gemini test program was initiated in order to determine that the tests planned for the spacecraft will adequately assure the flight worthiness of a manned spacecraft vehicle. The first phase of the review consists of an analysis of the testing now planned for the major spacecraft systems shown in table XX.

TABLE XX.- GEMINI SUBSYSTEMS

Gemini subsystems	Vendor locations
1. Digital computer	IBM, Owego, New York
2. Inertial measuring unit	Minneapolis-Honeywell St. Petersburg, Fla.
3. Attitude control and maneuver electronics	Minneapolis-Honeywell Minneapolis, Minn.
4. Attitude display group	Lear Siegler Grand Rapids, Michigan
5. Rendezvous radar	Westinghous Electric Baltimore, Md.
6. Horizon sensors	Advance Tech Labs Mountain View, Calif.
7. Environmental control	AiResearch Mfg Co. Los Angeles, Calif.
8. Reactants supply	AiResearch Mfg Co. Los Angeles, Calif.
9. Orbit attitude and maneuver	Rocketdyne Canoga Park, Calif.
10. Reaction control system	Rocketdyne Canoga Park, Calif.
11. Retrorockets	Thiokol Chemical Elkton, Md.
12. Time reference	McDonnell, St. Louis, Mo.
13. Voice communications	Collins Radio Cedar Rapids, Iowa
14. Data transmission	Electro-Mech Research Sarasota, Fla.
15. DC-DC converter	McDonnell St. Louis, Mo.
16. Digital command	Motorola, Inc. Scottsdale, Arizona
17. Fuel cell	General Electric West Lynn, Mass.
18. Space suit* (see note)	David Clark Co. Worchester, Mass

*Space suit test documentation package to be assembled by the contractor, using enclosure 4 as guidelines and under direction of the technical supervisor, Crew Systems Division.

A comparison of spacecraft hardware configurations presently in production, with the configuration used in the Design Approval Tests is being made. Those components whose production configuration differs from the design approval test configuration will require additional consideration to determine if the results of the tests can be used to qualify fully the hardware for manned flight. Future configurations going into design approval tests will be synomomous with production articles.

A qualification status listing showing the planned and completed qualification status of each part, component, sub-assembly, and higher level assembly is being prepared.

An extensive effort to detect weaknesses in the failure reporting and failure analysis program is in process so that a timely and efficient program can be realized prior to the first manned flight.

Two reliability meetings were held at MSC to coordinate the reliability activities of MSC and the prime contractor.

PROGRAM ANALYSIS AND REVIEW

GEMINI SPACECRAFT

Continual efforts have been made to improve coordination and the flow of meaningful information between the Gemini Program Office, McDonnell Aircraft Corporation, and their subcontractors in the area of status control and cost/schedule correlation. One of the results of these efforts is the establishment within McDonnell Aircraft Corporation of a Cost Evaluation Committee to assist in the timely evaluation of all phases of their Gemini effort. The committee consists of representatives from their engineering, manufacturing, procurement, budget, contracts, and program control organizations.

Evaluation by this committee is oriented primarily toward prediction of costs to completion of the various program elements under McDonnell Aircraft Corporation's responsibility, and is principally based upon correlation of accomplishments to date, work remaining, and costs incurred to date. Review and evaluation are performed in each of the approximately forty program control categories. Analysis is made of many factors, including engineering, development, test, and hardware production status; difficulties encountered or anticipated; effect of changes and program reorientations; subcontractor performance; schedule maintenance; and manpower requirements history and projections.

The results of the committee's analyses are documented in brief reports setting forth pertinent conclusions and recommendations. Upon review of these conclusions and recommendations and determination of action to be taken, McDonnell Aircraft Corporation revises their cost projections. These revisions are reflected in the NASA Form 533, Financial Status Report.

GEMINI LAUNCH VEHICLE

As one of six subsidiary panels of the recently chartered Gemini Launch Vehicle Coordination Committee, a Cost, Contracts, and Schedules Panel has been established. This panel is responsible for evaluation of cost, contract, and schedule information; program status; and advance determination of items adversely affecting maintenance of program progress milestones. Methods of reporting costs and correlation of program progress and expenditure of resources will be a subject of primary concern. The Cost, Contracts, and Schedule Panel will be composed of representatives of the MSC Gemini Program Office, the MSC Program Analysis and Resources Management Office, the MSC Gemini Procurement Office, the Air Force Space System Division, Martin Marietta Corporation/Baltimore, Aerojet General Corporation, and Martin Marietta Corporation/Cape Kennedy.

REFERENCE

1. Evaluation of a Full-Scale Gemini Abort System in an Altitude Test Cell (U), AEDC-TDR-63-230, Confidential Document, dated November 1963.

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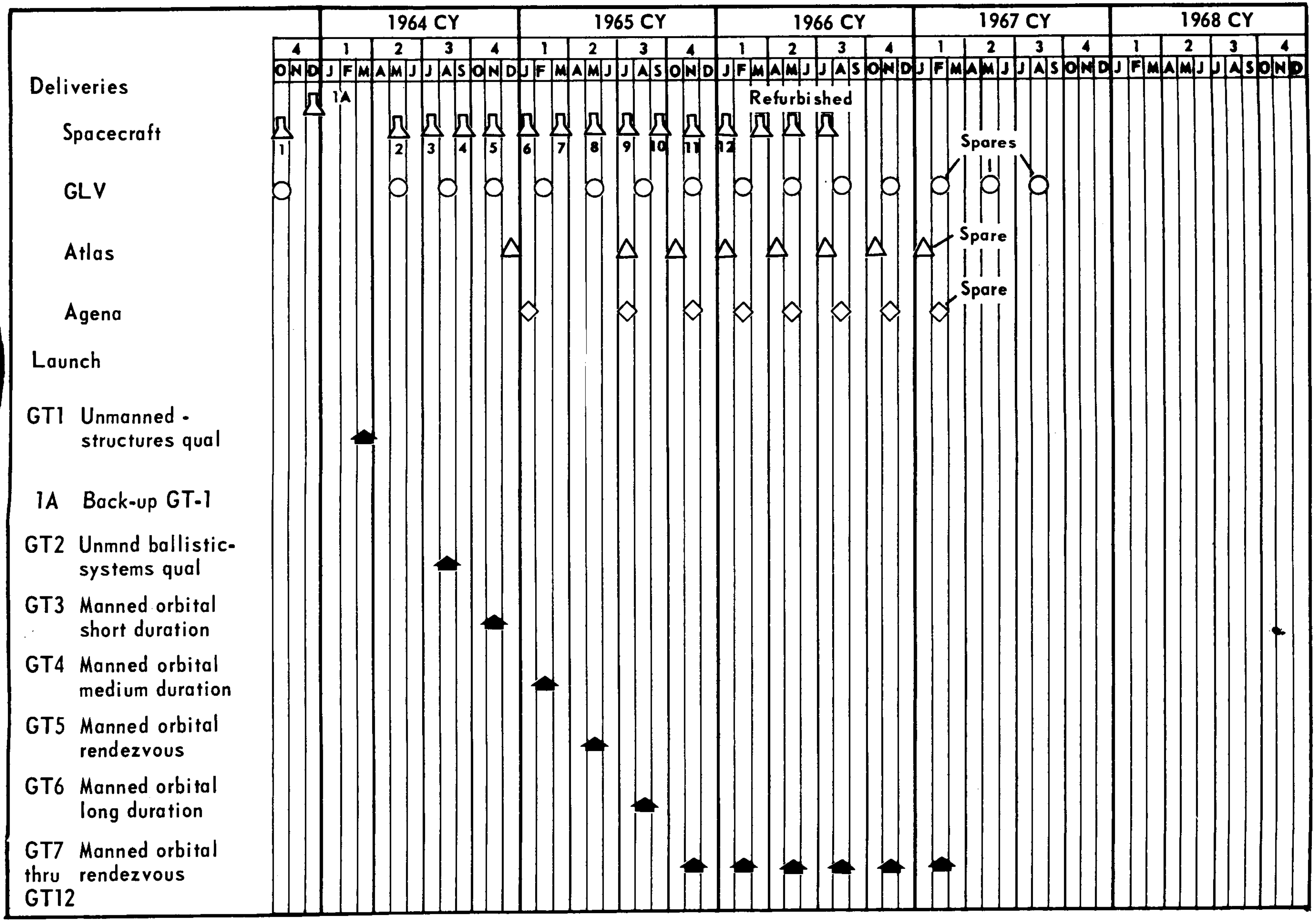
Gemini launch schedule (Proposed Dec 1963)



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